Engineering
Library

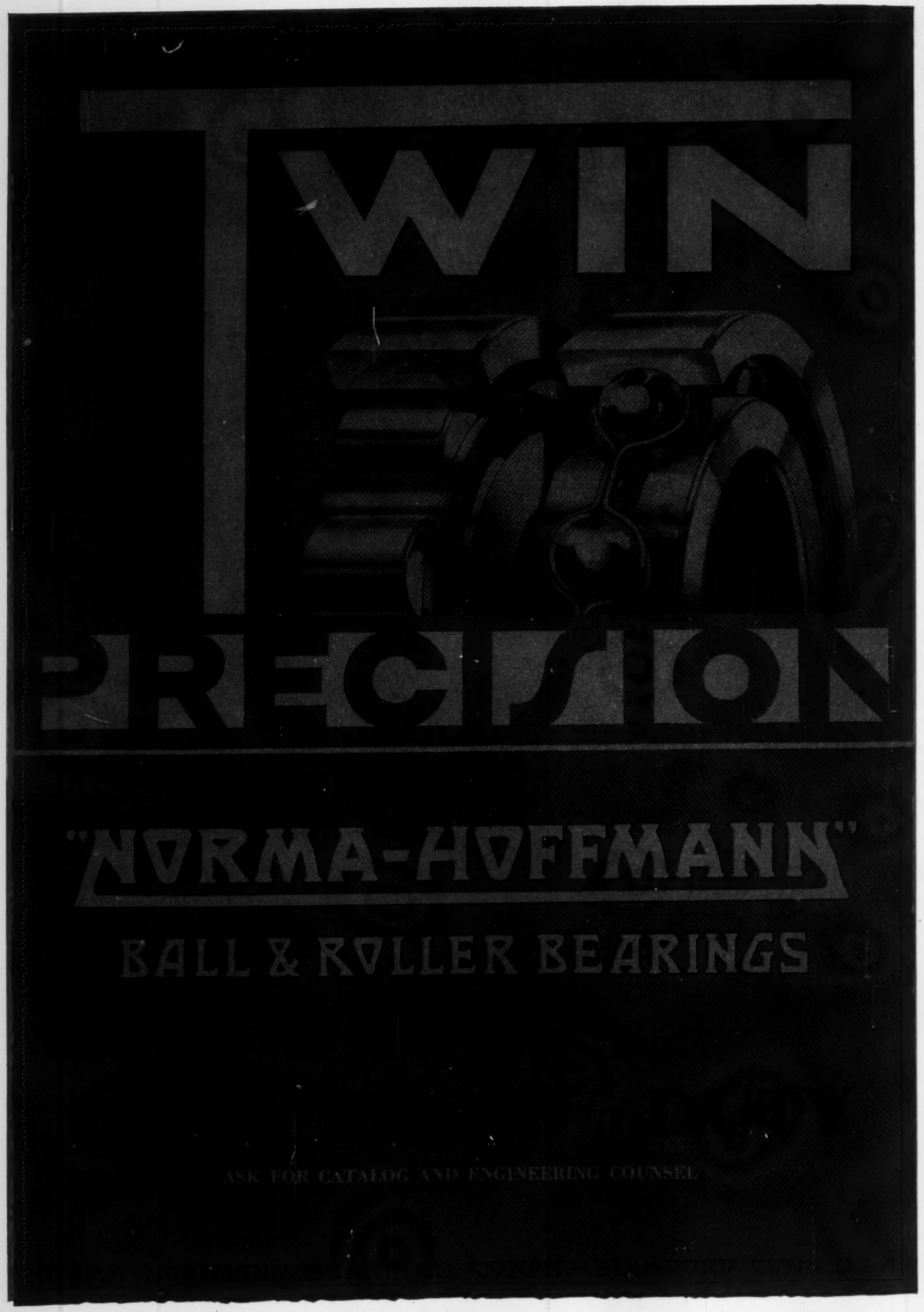
JUN 11 1931

JUNE 1931

MACHINE DESIGN

AS IT AFFECTS

ENGINEERING—PRODUCTION—SALES

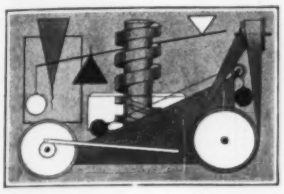

TWIN
PRECISION
"NORMA-HOFFMANN"
BALL & ROLLER BEARINGS
ASK FOR CATALOG AND ENGINEERING COUNSEL

MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Volume 3 **June, 1931** **Number 6**



Forthcoming ISSUES

ONE of the outstanding controversial topics of today centers around the possibility of utilizing diesel engines for passenger automobiles. This question involves closely the matter of design. Can the diesel be refined to the point where it will serve as an even more satisfactory prime mover than the gasoline engine?

An article is scheduled to appear in an early issue dealing comprehensively with this far-reaching subject. In it are discussed advantages and disadvantages of the diesel for this purpose. The article is by one of the leading engineers in the automotive field and undoubtedly will be read with intense interest in view of the showing of the diesel car at Indianapolis.

L. E. Jermy

Managing Editor

CONTENTS

(FOR COMPLETE ITEMIZED INDEX OF CONTENTS, SEE PAGE 7)

	Page
Co-ordinating Engineering With Other Company Activities *By L. E. Jermy*	27
Scanning the Field for Ideas	30
Combating Wear of Tractor Parts *By H. B. Veith*	33
An Unusual Flexible Drive *By H. F. Shepherd*	36
Problem of Torsional Vibration Increases With Engine Power *By J. Ormondroyd*	37
Failure of Machine Parts *By L. T. Holt*	41
Gear Progress Aids Designers	44
Standardizing Cylindrical Fits To Simplify Design *By John Gaillard*	45
Rubber Compounds Find Many Uses in Design *By F. L. Haushalter*	48
Bearings Operate Efficiently at 500 Degrees Fahr	51
Taxation of Labor-Saving Machinery Would Stifle Industry (Editorial)	52
A Brief History of the Printing Press	53
Professional Viewpoints	54
Men of Machines	56
Noteworthy Patents	60
Topics of the Month	64
How Is Business	68
New Materials and Parts	70
Manufacturers' Publications	86
Business and Sales Briefs	88
Calendar of Meetings and Expositions	24

Published on the tenth of each month by

THE JOHNSON PUBLISHING CO., PENTON BUILDING, CLEVELAND, O.

in affiliation with The Penton Publishing Co.

FRANKLIN H. JOHNSON, Publisher: L. E. JERMY, Managing Editor; W. C. KREMSER, Circulation Manager; H. B. VEITH, A. F. CLARK, Editorial Representatives; HOWARD H. DREYER, Western Manager, 1347 Peoples Gas Bldg., Chicago; Penton Publishing Co. Ltd., Caxton House, Westminster, London, S. W. 1, European Representative

Subscription rates: United States and Canada, two years, $5.00: one year $3.00. Europe, two years, £1.13.6; one year, £1. Single copies, 35 cents.

Copyright, 1931, by The Johnson Publishing Co., Penton Building, Cleveland. All rights reserved.

Alloy steel and iron bear the brunt

The past decade's revolutionary advance in the application of high speeds, high pressures, and high temperatures to mechanical production and chemical processes has necessitated the working out of a tremendous number of alloy steel and iron analyses, each designed to meet some specific requirement of this new age.

High strength at high temperature . . . high strength combined with light weight . . . complete resistance to corrosion under varying conditions . . . increased wear resistance . . . immunity from the effects of shock and fatigue . . . these are but a few of the manifold demands that are met daily by the proper use of Ferro-Alloys.

Any metal part used in your product or equipment can be benefited by some one or more of the inherent advantages of Ferro-Alloys. It will pay you to investigate thoroughly the latest developments in high temperature metallurgy and to let Electromet Engineers explain how required physical and chemical properties may be provided by the use of Ferro-Alloys.

Sole Distributors

ELECTRO METALLURGICAL SALES CORP.
Unit of Union Carbide UCC *and Carbon Corporation*
Carbide and Carbon Building, 30 East 42nd Street
New York, N.Y.

Electromet
Ferro-Alloys & Metals

Itemized Index for June, 1931

Key: Edit, Editorial Pages; Adv, Advertising Pages; R, Right hand column; L, Left hand column

Compiled for the assistance of engineers confronted with specific design problems

Design Calculations:

Roller Pressures, Edit. 55 R

Torsional Critical Speeds, Edit. 37, 38, 39, 40

Design Problems:

Applying Rubber in Machines, Edit. 48, 49, 50

Combating Wear, Edit. 33, 34, 35

Employing Remote Control, Edit. 31 R, 32 L

Obviating Failure of Steel Parts, Edit. 41, 42, 43

Overcoming Wind Resistance, Edit. 30

Reducing Torsional Vibration, Edit. 37, 38, 39, 40

Setting Tolerances, Edit. 45, 46, 47, 66 R

Strengthening Construction, Edit. 34 L

Studying Noise, Edit. 30

Use of Bearings Under Heat, Edit. 51

Materials:

Alloys (General), Edit. 31 L

Alloys (Iron), Adv. 11

Alloys (Nickel), Adv. 19

Alloys (Steel), Adv. 6

Cork, Edit. 34 L; Adv. 21

Rubber, Edit. 48, 49, 50

Steel, Edit. 41, 42, 43

Mechanisms:

Loading, Edit. 32 R

Steering, Edit. 35 R

Organization and Equiment:

Of Engineering Department, Edit. 27, 28, 29, 54 L, 55 L

Parts:

Bearings, Edit. 51, 54 L, 70 L, 77 R; Adv. 2, 10, 13, 15, 18, 20, 61, 67, 80 L, 88 L, 89, 91, 94

Clutches, Adv. 69, 71

Contact Points, Adv. 78 L

Controls (Electrical), Edit. 72 R, 77 L; Adv. 3, 26

Couplings, Edit. 36, 80 R; Adv. 90 L

Drives, Edit. 54 R, 60, 62 L, 77 R; Adv. 8, 9, 25, 65, 73, 74 L, 79

Fastenings, Edit. 74 R; Adv. 14, 23, 85

Gears and Gear Blanks, Edit. 44, 70 R, 72 L; Adv. 23, 63

Heating Units, Adv. 83

Lock Washers, Edit. 70 L; Adv. 82 L

Lubricating Equipment, Edit. 34, 35, 80 R; Adv. 75, 76

Motors, Edit. 82 R; 84 L; Adv. 16, 22, 91, 87, 93

Packing Glands and Packing, Edit. 33; Adv. 4, 90 L

Pulleys, Edit. 77 L

Pumps, Edit. 62, 74 R, 78 R, 84 L

Stampings and Pressed Parts, Edit. 34

Valves, Edit. 84 R

Welded Parts, Edit. 72 R; Adv. 17, 81, 92

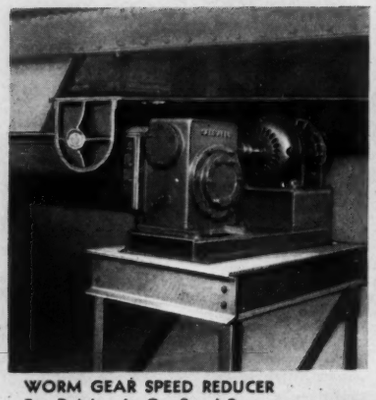
Standardization:

Cylindrical Tolerances, Edit. 45, 46, 47 66 R

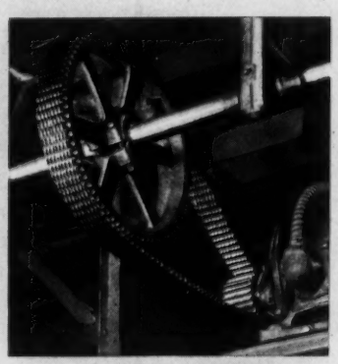
Screw Threads, Edit. 64

MANY readers of Machine Design tell us they keep a complete file of copies for reference purposes. To enhance the usefulness of our publication to those readers, an index, covering the entire year's copies, is published each January and offered to subscribers without charge. This, with the itemized index compiled from each issue, constitutes a complete reference volume.

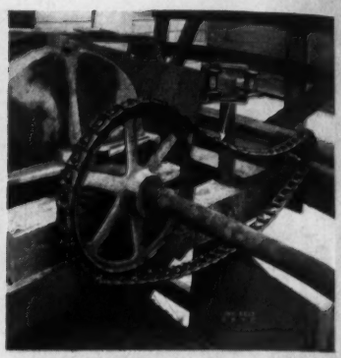
To expand further the usefulness of such a file, we gladly will bind readers' copies in an attractive leather cover. Copies, however, often become worn or damaged through use and handling. For those organizations desiring, we will lay aside a fresh copy each month and automatically bind them at the end of the year. Charges are nominal, covering cost of copies and binding only.



WORM GEAR SPEED REDUCER
For Driving in Confined Space

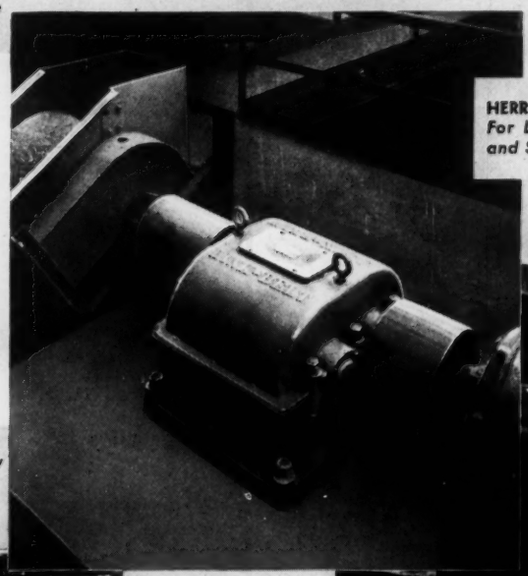


SILENT CHAIN DRIVE
For High Speed Transmission Service

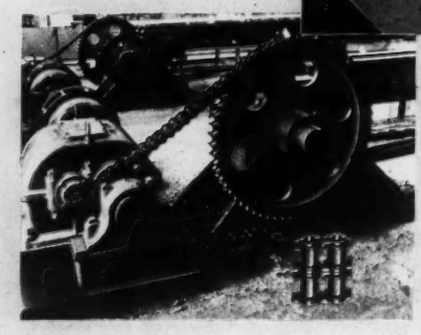


CHAIN DRIVES (Steel, Malleable or Promal)
For Many Average Classes of Service

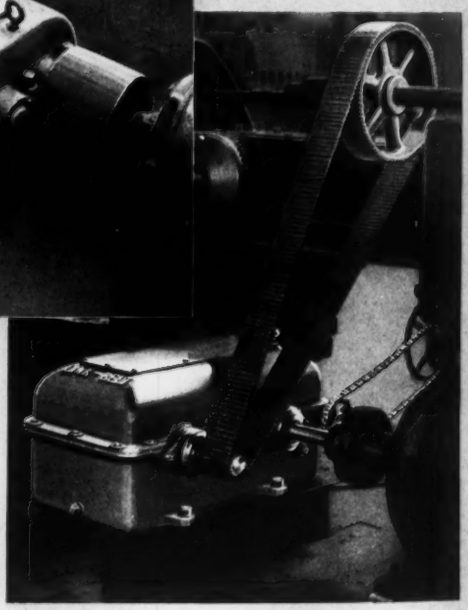
HERRINGBONE GEARS
For High-Performance Machinery



HERRINGBONE SPEED REDUCER
For Large Reductions, Heavy and Shock Loads



ROLLER CHAIN DRIVE
For Moderately High Speed Transmission



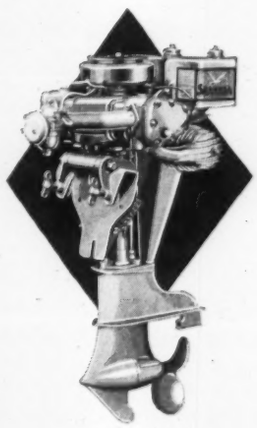
P. I. V. GEAR
For Positive, Infinitely Variable Speed Control

LINK-B

BRISTO-DARDELET

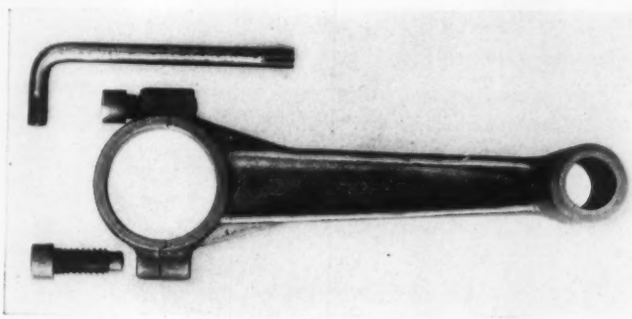
SOCKET HEAD CAP SCREWS

are standard in the connecting rods of "Sea Gull" Four Cycle Outboard Motors.



CROSS GEAR & ENGINE COMPANY of Detroit, Michigan, devoted ten years to perfecting their "Sea Gull" motor—the only four cycle outboard motor on the market. They have succeeded in producing at a reasonable cost, a powerful outboard motor which is light in weight, quiet, simple and inexpensive to operate. All materials specified have been chosen for lasting, reliable performance with a minimum of attention.

The reasons why Cross Gear & Engine Company have standardized on Dardelet-threaded Bristo Cap Screws are given in the letter reproduced below:



"Sea Gull" connecting rod assembly showing Dardelet-threaded Bristo Socket Head Cap Screws, and Bristo Wrench. *Above*—"Sea Gull" Four Cycle Outboard Motor, service or utility model for family boats, runabouts, cruisers, work boats.

BRISTO-DARDELET Socket Head Cap Screws and Safety Set Screws are manufactured and distributed by

THE BRISTOL COMPANY

WATERBURY, CONNECTICUT

■ ■ ■

Phone MELROSE 1939 Cable Address "CROSSGEAR"

CROSS GEAR & ENGINE COMPANY

MANUFACTURERS OF

CROSS PRODUCTS

3200 BELLEVUE AVENUE
DETROIT, MICH.

April 29, 1931.

DARDELET THREADLOCK CORPORATION
130 Broadway
New York - NY

Gentlemen:

It might be of interest to you to know that after carrying on a series of exhaustive tests over a long period of time, we have decided to standardize on Dardelet Thread and Dardelet Threaded Screws in the connecting rods of our Sea Gull Outboard Motors.

Our reasons for reaching this decision are:

First - When Dardelet Threaded Screws are once tightened up, they will remain tight indefinitely.

Second - We have found that Dardelet Threads are much stronger than any of the common standard threads, and on account of their larger sections, are much less apt to fatigue under heavy loads over long periods of time.

We wish you the utmost success with this very satisfactory Thread.

Yours very truly,
CROSS GEAR & ENGINE COMPANY
R. E. Cross - Chief Engineer.

R-H

THE DARDELET SELF-LOCKING SCREW THREAD IS PATENTED AND IS MANUFACTURED IN THE UNITED STATES UNDER LICENSE FROM THE DARDELET THREADLOCK CORPORATION . . . IF YOU HAVE TROUBLE IN KEEPING THREADED FASTENINGS TIGHT, WRITE US.

DARDELET THREADLOCK CORPORATION **120 BROADWAY, NEW YORK, N. Y.**

CALENDAR OF MEETINGS AND EXPOSITIONS

June 14-19—Society of Automotive Engineers. Papers to be presented at the spring meeting to be held at White Sulphur Springs, W. Va., include: "Practical Experience with Devices for Damping Torsional Vibration," by Erich Sandner and J. B. Frauenfelder; "Air-Cooled Cylinder Head Design," by Roland Chilton; and "Oil Control in the Engine," by H. C. Mougey.

June 15-17—American Society of Mechanical Engineers. The applied mechanics division will hold a meeting and exposition of research apparatus including photoelastic equipment, gear damping, balancing machine models, and sound deadening devices at Purdue university, Lafayette, Ind. Technical papers which include: "Spiral Springs," by J. Van den Broek; "Recent Advances in Photoelasticity," by M. M. Frocht, "Strength of Materials in Shear," by F. L. Everett; and "A New Balancing Machine," by E. L. Thearle, are grouped in four sessions as follows: "Stress-Analysis"; "Stress Analysis and Plasticity"; "Vibration"; and "Hydrodynamics." Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary.

June 15-19—Association of Iron and Steel Electrical Engineers. Annual meeting and iron and steel exposition to be held in conjunction with the Wire association at Public Auditorium, Cleveland. Papers include: "Electrical Developments in the Iron and Steel Industry," by W. H. Burr; "Motor and Control Equipment for Cold Strip Mill Drives," by F. Mohler; "Twin Motor Drives," by R. H. Wright and H. E. Stokes; and "Lubrication of Machine Tools," by J. H. VanCampen.

June 17—Society for the Promotion of Engineering Education. Discussions of interest to be presented at the meeting at Purdue university, Lafayette, Ind., include: "The Selection of Design Engineers," by Edwin H. Brown, A. O. Smith Corp., Milwaukee; and "The Content of Courses in Machine Design and Related Subjects," by James A. Hall, professor, Brown university, and consulting engineer, Brown & Sharpe Mfg. Co., Providence, R. I. Information on the meeting may be obtained from Frank L. Eidmann, Columbia university, New York.

June 22-26—American Society for Testing Materials. Thirty-fourth annual meeting and exhibition of equipment and apparatus used in testing, and recording and control equipment, at Hotel Stevens, Chicago. The technical program will include symposiums on "Effect of Temperature on the Properties of Metals," "The Economic Significance of Specifications for Materials," and "Malleable Iron Castings." Papers will include: "Damping Capacity of Materials," by G. S. von Heydekampf; "Relation Between Magnetic Properties, Impact Strength and Hardness," by Haakon Styri; "Fatigue Tests of Welds," by R. E. Peterson and C. H. Jennings; "A Seven-Ton 50-Cycle Fatigue Testing Machine," by B. P. Haigh and T. S. Robertson; "The Static and Fatigue Properties of Brass," by J. B. Kommers; and "The Phenomenon of Slip in Plastic Materials," by Dr. A. Nadai. C. L. Warwick, 1315 Spruce street, Philadelphia, is secretary.

June 22-26—American Institute of Electrical Engineers. Included in the program for the annual meeting of the society to be held in Grove Park Inn, Asheville, N. C., are the following technical sessions: Electrical machinery, symposium on electrical units; and a session on research, selected subjects, and technical committee reports. F. L. Hutchinson, 33 West Thirty-ninth street, New York, is secretary.

June 23-26—American Society of Mechanical Engineers. Fourth national oil and gas power meeting, and exposition of parts and accessories, to be held at University of Wisconsin, Madison, Wis. Papers to be presented include: "Observation of European Diesel Developments"; "Development of Double Acting Diesels"; "Design of an Automatic Diesel Plant"; and "Light-Alloy Pistons and Rods in High-Speed Industrial Engines." L. H. Morrison, associate editor, *Power*, Tenth avenue at Thirty-sixth street, New York, is in charge of the program.

June 23-26—American Society of Heating and Ventilating Engineers. Annual meeting and exposition at Swampscott, Me. A. V. Hutchinson, 51 Madison avenue, New York, is secretary.

Aug. 4-8—Universal Craftsmen Council of Engineers. Annual meeting at Stevens hotel, Chicago. T. H. Jones, 33 Linden avenue, Cherrydale, Va., is grand secretary of the council.

Aug. 23-29—International Industrial Relations congress. To be held at Amsterdam, Holland. Information may be obtained from Mary van Kleeck, Russel Sage Foundation building, New York.

MACHINE DESIGN
THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO
June, 1931 Vol. 3—No. 6

Co-ordinating Engineering with other Company Activities

By L. E. Jermy
Managing Editor, Machine Design

MANY engineers like to believe that engineering is an exact science and that members of the profession are fortunate in that they deal with tangibles rather than intangibles.

This is true, insofar as the internal problems of engineering are concerned, but in his relations with heads of other departments and with individuals outside of his own company a chief engineer cannot escape the necessity of coping with numerous vague and indefinite factors. In fact that phase of engineering which has to do with working harmoniously with other persons is anything but an exact science.

Therefore the engineer who attempts to broaden the sphere of his activities along the lines outlined in the first article of this series, which appeared in the May issue, immediately comes face to face with the problem of co-operation—a form of activity involving more intangibles than any other phenomena of business. Here and there one may find an eccentric chief engineer, who through unusual ability and because of unusual conditions may achieve a fair degree of success while leading the life of a hermit in an engineering department tightly shut off from the rest of the plant. Occasionally inventors or skilled specialists can perform their work better when they are given facilities for seclusion and independent effort. But in the majority of cases, the most successful engineers —and certainly those of greatest value to their employers—are those who know how to co-operate. An able chief engineer who is also a good "organization man" is doubly valuable.

This view is held by many chief executives. Recently the head of an important machinery manufacturing company declared that he was elated because at last his engineers were "entering into the operating policies of our business." Until a year ago the engineering department of this company had remained aloof from other departments. The chief engineer was a czar in his own domain, who discouraged contact with other activities. Inroads of the depression prompted a study of the functioning of the important departments and when it was discovered that the Chinese wall surrounding the engineering department was responsible for numerous inefficient practices, it was demolished. Today the chief engineer is an interest-

ed member of the official family and he is bringing the full force of the talent and ability of his staff to bear upon all company policies and problems in which engineering is a factor.

The experience of this company may be extreme, but in other respects it is not exceptional. There are hundreds of plants in which a Chinese wall surrounds the engineering department, although it is not yet visible to the management. In many cases the wall has been erected unconsciously by engineers who do not appreciate the advantages of freedom for co-operation. In other instances, the barrier is a tradition, carried down from the era when design activities were counted most precious of trade secrets.

In any event, unnatural obstructions to the flow of ideas into and from engineering departments have no place in modern industry. Today the tendency in management is to synchronize the work of the divisions of a company so that the result is a smoothly running machine. The functions of engineering must harmonize with those of general administration, finance, purchasing, production, sales and service.

Progressive companies are finding it desirable to set up machinery which will facilitate co-operation between these departments. In numerous establishments, the usual interchange of information by means of inter-office memoranda, reports and visits is augmented by regular inter-departmental conferences, special meetings and standing committees.

FROM the number and character of unsolicited letters received by the editors of MACHINE DESIGN commending the publication for its leading article in the May issue, it is apparent that many leaders in the profession approve the idea that engineers should give more attention to external problems. Dozens of leading engineers, whose names rank high in the field of machine design, confirm our belief that the greatest opportunities for elevating the standards of the design profession lie in the broadening of engineering functions.

This being true, the next logical step is to point the way to these desirable broader relationships. The accompanying article shows how typical companies are solving this problem.

—The Editors.

Procedure Follows No Set Rule

The use of these aids to co-operation varies so widely in different plants that it is impossible to prescribe a plan suitable for all companies. Every manufacturer has problems peculiar to his own organization, and for that reason a system of weekly conferences which has proved to be desirable for one company may fail miserably when adopted by a contemporary. The size of plant, type of organization, character of product and many other factors will influence the selection of a suitable plan of co-operation.

Recognizing this wide variety of conditions, the editors of MACHINE DESIGN have studied the inter-departmental relations of more than a score of companies, each of which is typical in its field. The results of these case studies should be valuable to those who are seeking a plan for promoting better co-operation between the engineering and other departments.

In analyzing the experience of 23 companies, it was found that a number of plans are almost identical except for minor details. After eliminating these duplications and weeding out systems which admittedly have not proved entirely successful, the number of workable, distinctive plans was reduced to eight. Their principal features are shown in the accompanying table.

It will be noted that while the purpose of the 13 committees or conferences listed in the table is not always primarily of an engineering character, nevertheless the chief engineer participates in every one. In fact he is the only department head whose presence is checked 13 times. The works manager ranks second with 12 checks. The sales manager is third with 9 and the president or general manager fourth with 7.

Five of the companies have found that a standing committee facilitates the exchange of ideas on engineering and design problems. The engineering committee of No. 1 company is of unusual interest because it functions continuously. Meetings are held at the call of the chief engineer, but its acts are so important that a permanent secretary is employed to supervise details in the interims between sessions. The committee has broad authority on all matters of engineering and production which affect design. Decision to bring out a new model is up to the president and some of the directors. But with this exception, the committee rules on all factors influencing design.

Company No. 2 has the largest committee in the list. The weekly sessions of this body are forums at which the representatives of all departments discuss design from the standpoint of purchasing, costs, production, inspection, sales, service, etc. The committee's function is advisory in that final authority on design rests with the chief engineer, subject to approval of the president. However the weekly meetings give every interested department an opportunity to present its case, and therefore many unforeseen difficulties are brought to light and ironed out before a design is adopted.

The development committee of Company No.

3 and the design committees of Companies Nos. 4 and 8 are similar in function to that just described but embrace fewer members and do not meet regularly.

Company No. 5 holds weekly conferences for engineering and manufacturing personnel and monthly meetings for sales, engineering and manufacturing chiefs. The weekly round table sessions are informal and are for the purpose of co-ordinating shop and engineering activities. The company has found that once a month is the "correct period for transmitting field data to the factory and engineering departments and for keeping the sales manager informed of inside operations"—hence the sales meeting is a monthly affair.

Contrary to the experience of most of the 23 companies investigated, Company No. 7 employs a daily conference to good advantage. Its product is special machinery and almost every order involves individual problems of design. For this reason the president, chief engineer and factory and sales managers meet every day to go over these problems. In plants where the product is standardized every-day conferences probably would retard rather than assist co-operation between departments.

The "policy conference" of Company No. 8 is interesting in that it deals with consideration of new products, establishing or revising prices, revamping design and discussing service. The chief engineer, sales manager, works manager and occasionally the purchasing agent participate in these sessions.

It is noteworthy that all companies report that the committees and conferences do not take the place of regular contacts between departments. These sessions are supplementary to inter-office communications, informal visits, etc.

Field Contact Is Essential

Enterprising engineers find many other ways of keeping in touch with activities outside of their own departments. One chief engineer sets aside several weeks twice a year for trips into the field to study the performance of his company's product. Another occasionally travels with the sales manager to get the "feel" of consumer attitude through district salesmen. Another frequently joins his inventor in visits to places where their machines are used.

A good system of committees or conferences can be helpful in encouraging contact between the engineering and other departments, but it cannot take the place of initiative on the part of the chief engineer. In the final analysis, it is he who can make his department a walled-in hermitage or an alert, enterprising unit working harmoniously with other departments.

How Eight Companies Employ Committees and Conferences

	Size of Plant	Type of Product	Method of Co-operation	Participants* P. or G.M.	Ch. Eng.	S.M.	W.M.	P.M.	P.A.	C.I.	S.C.	Exp.	S.D.	Inv.	Others	Frequency of Meeting	Remarks
1.	Large	Automotive	Engineering committee		√	√	√									When necessary	Committee, with permanent secretary, has broad authority on design.
2.	Medium	Electrical	Design committee	√	√	√	√	√	√	√	√	√	√	√	√	Weekly	Proposed designs, after approval by chief engineere considered bythiscommitte.
3.	Medium	Paper Machinery	Development committee		√	√	√						√	√	√	When necessary	Exchanges ideas on design
4.	Small	Material Handling Equipment	a) Sales meeting		√	√										Every two months	Opportunity for engineering advice on sales policies
			b) New design committee	√	√	√	√	√								When necessary	Affords discussion prior to adoption of design
5.	Large	Textile Machinery	a) Round table	√	√		√	√		√						Weekly	For facilitating handling of routine problems
			b) Sales meeting	√	√	√	√				√					Monthly	Deal with design as it affects sales
6.	Small	Heavy Machinery	Luncheon meeting	√	√	√	√						√		√	1 or 2 per month	Informal, to discuss design and production problems
7.	Small	Machine Tools	a) Design and production conference	√	√	√	√									Daily	Company builds special machines, necessitating frequent check-ups
			b) Design meeting		√		√									When necessary	Deals with design from manufacturing angle
8.	Medium	Electric	a) Production conference		√		√	√	√							Weekly	Discuss design and production
			b) Policy conference		√	√	√		√							When necessary	Prices, new designs, service
			c) Design committee	√	√		√					√				When necessary	Advisory on new or revised models

*Key: P, president; G.M., general manager; S.M., sales manager; W.M., works manager; P.M., production manager; P.A., purchasing agent; C.I., chief inspector; S.C., supervisor of costs; Exp., head of experimental department; S.D., head of service department; Inv., inventor.

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

DEFINING an idea as a product of mental activity, it can be seen that one of the easiest ways for the designers of machinery to produce new ideas is to follow closely the trends in other industries as well as their own. Engineers must watch, among other things, developments in remote control, materials, noise abatement, streamlining and progress in new methods of transportation. These are some of the subjects considered in succeeding columns, reflecting new tendencies in meeting the requirements of the age.

Study Noise Abatement Problems

NOISE in operation of machinery has become the object of a concerted attack with elimination as far as possible the ultimate purpose. Associations and noise abatement commissions have made an organized effort to combat the disturbances. Reports as to cause and effect are supplemented with suggestions which for the most part are directed to the maintenance engineer.

While this work is accomplishing its end admirably as far as machines already in use are concerned, it remains for the designer to apply his ingenuity to the layout of new machinery. To combat noise properly, steps must be taken in the original design of a unit.

Numerous experiments have been tried, among which have been included tests to stop the ringing of rail car wheels and gears. By bolting pads of rubber on wheels it was found that this had a quieting effect on the operation of trolley cars. Another detail which seemed to eliminate some of the noise was the construction of a vertical skirt carrying sound absorbing material, around the contour of the lower frame of the car.

It is interesting to note that some automobile bodies now incorporate an idea which might be applied to machines where metal-to-metal friction contact in joints is a source of noise. Friction tape, rubber, felt and other antifriction and sound proofing materials are used between the joints where rubbing surfaces occur. An antifriction paste made up of asbestos-graphite in an oil vehicle also is imbedded in joints. According to a recent article in *Automotive Industries*, the Murray company recently adopted a new material which essentially is a webbed fabric impregnated with a heavy grease or fat. In a test the sample could not be made to squeak and the lubricating material did not break down when the sample was subjected to a steam test at 275 degrees Fahr.

Streamlining Enters Railroading

AS POINTED out in previous issues of MACHINE DESIGN, ideas arising from the practical application of the laws of aerodynamics are migrating from one industry to another. The airplane and the automobile have interchanged design experience, as discussed on page 31 of the February, 1931, issue. Now comes a streamline locomotive, recently conceived by O. Kuhler,

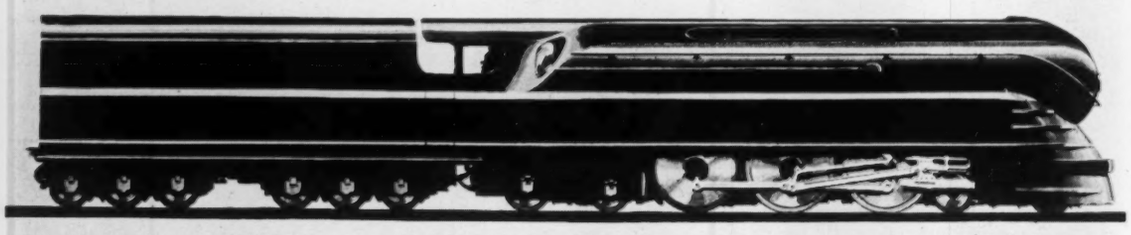


Fig. 1—Streamlining of a locomotive is indicative of a possible future trend in design

design engineer, New York. Its graceful contour is well illustrated by the picture shown in Fig. 1.

In addition to reduced wind resistance, improved appearance and features for providing ease in cleaning, the new design incorporates a number of other noteworthy innovations. The headlight is recessed in the smokestack cowl, smoke deflectors are utilized, the handrail is stainless steel, shields covering the upper part of the drivers are hinged to give easy access to all hidden parts, steps above the cylinders are streamlined and connecting rods are highly polished.

Alloy Developments Important

RESEARCH in metals to find cheaper substitutes has been going on for many years, but there probably is no one instance where results have been any more successful than those of Dr. E. F. Lowry, research physicist at Westinghouse laboratories, who discovered konel as a substitute for platinum. Because platinum costs $186 an ounce he set out to find another metal which could be emplcyed in filaments in radio tubes. Konel was the result, but in addition to the purpcse of its initial application, the unusual characteristics of the alloy give promise of many other uses, including valves for diesel engines, turbine blades or other parts which must withstand temperatures equal to red heat.

In connection with discovery of konel it is interesting to note the more important properties of the alloy. It not only appreciably increases life of the radio tubes, operating 175 per cent

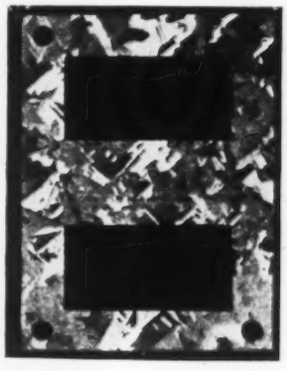


Fig. 2—Grain structure of hipernik, a high permeability magnetic alloy which brings to the electrical industry a new material for the designer. This alloy now is being produced commercially

colder than platinum filament, but also shows definitely that the filament core had a marked influence on electron emission.

Another unusual alloy, arrangements for which recently were made to produce it commercially, is hipernik. Classified as a high permeability nickel material, it possesses supermagnetic qualities and was discovered by Dr. Trygve D. Yensen, Westinghouse research engineer. Fig. 2 shows the grain structure which is made up of billions of atoms of iron and nickel.

Until the present time the alloy was made on a small scale and has been costly. Now it is being rolled in sheet form or as cold rolled strip for transformers, motors and other electrical equipment in which high magnetic permeability is desirable. The alloy is claimed to be 30 times as magnetic as ordinary open-hearth steel or iron.

Trend Is Toward Remote Control

SINCE the inception of remote control, which at first was confined to smaller types of machinery where operation was comparatively

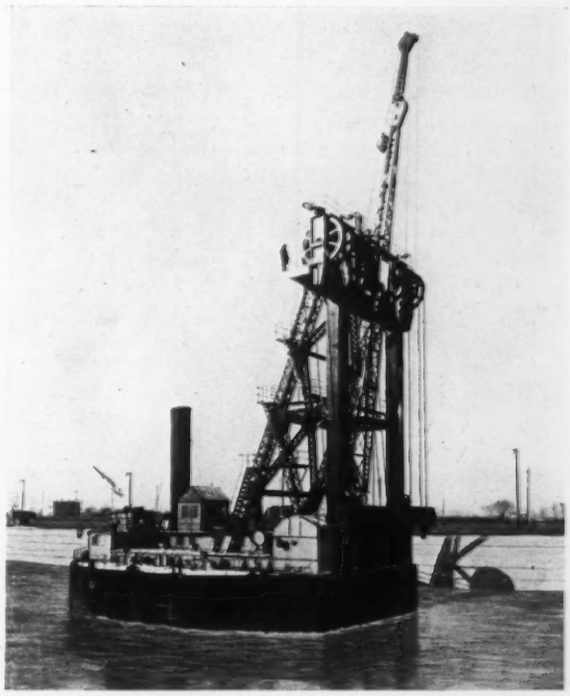


Fig. 3—Remote control is an outstanding feature of this canal lock gate lifter

simple, designers gradually have extended its application to larger equipment. One of the outstanding examples where facilities were concentrated to control a massive machine, is the lock gate lifter now undergoing tests successfully in the Welland ship canal in Canada. With a capacity of 500 tons, this large floating crane, shown in Fig. 3, is said to hold the distinction of being the largest in capacity ever built.

When it is considered that frcm the control room on top of the deckhouse amidships, the movements of the hoisting machinery, operation of the ballast pumps and ballast line manifolds are controlled, it seems possible that similar arrangements could be provided for smaller types of equipment. Moreover, valves for controlling the fluid equalizing system, the gages indicating pressure in the cylinders and telegages for showing the amcunt of water in the various ballast tanks are located there, thus

providing complete centralization of controls.

Telephone communication between the man in charge of the gate lifter and the operator at the controls provides perfect co-ordination. The main hoist is driven by four 50-horsepower motors, each driving through gears a large screw which carries back and forth a carriage around which the cables are looped. Each of the four motors within certain limits may be operated independently, but when a gate actually is being lifted they must be clutched together. This is done to give a uniform lift and also to minimize any chance of overbalancing the pontoon.

Balance of the pontoon is maintained by means of shifting water ballast. Three forward, three aft and two athwart ship tanks are provided with necessary pumps and electrically operated valves for transferring water. Control of the ballast pumps is provided by means of a disk in the control room. The water level is indicated by a set of telegages mounted in the same room. In order to reduce possibility of an unequal lift, the cables at the lower ends are anchored to plungers in hydraulic cylinders. Each cylinder has a pressure gage located in the control room to indicate cylinder pressure which is proportional to the stress on the cable.

Design plans and specifications of the gate lifter were made by Wellman Engineering Co., Cleveland, and electrical equipment was furnished by Canadian Westinghouse Co. Ltd. From the accomplishments in this large unit the designer in other fields will find the idea of performing a diversified number of operations by remote control particularly beneficial. In that type of machinery where it is necessary for the operator to know the status of several functions of his machine the plan followed out by the engineers in designing the lock gate lifter might well be considered.

Unique Idea in Transportation

FOLLOWING closely in its basic idea a type of machine used in lumber camps, the Willamette utility carrier shown in Figs. 4 and 5, incorporates unusual design features. Because of its unique construction and operation it is finding wide use in the transportation of lumber, pipe, steel, pulp, paper, tile, bricks, etc.

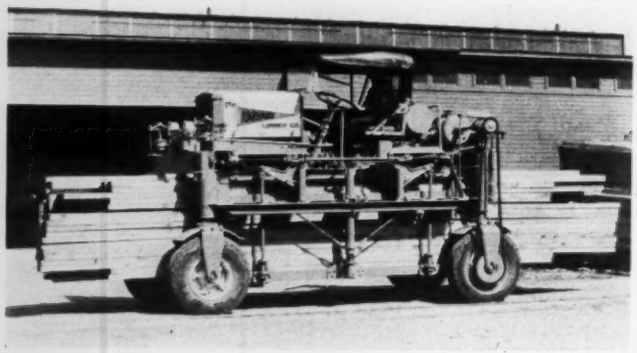


Fig. 4—Utility carrier incorporating revolutionary ideas in transportation methods

In the lumber yard for instance, loading is accomplished by driving the machine straddle of the pile and without moving from his seat the driver hoists the load which rides in a suspended carriage beneath the chassis. Other features are its ability to travel at the rate of 45 miles an hour and capacity of 15 tons.

Fig. 5—Front view of utility carrier showing facility for straddling load

This self-loading and unloading unit provides an excellent example of the possibilities afforded the designer in meeting new requirements in transportation.

Mechanical features of the utility carrier are interesting. One innovation is the utilization of the load lifter to raise the entire machine off its wheels. This is accomplished by lowering the lift to provide a jack. The load hoist is operated through two large horizontally opposed screws rotated by a chain driven through a dry friction clutch. By means of rocker arms, one on top of each wheel post, the bed is held in flexible suspension. All four wheels are operated in unison by the steering device. Universal joints on the drive shaft which carries the sprockets of the chain driving arrangement compensate for any shock.

Although the utility carrier can be used for transporting other commodities, it has found wide application in the lumber industry, the Harvard Lumber Co., Cleveland, being typical users. The manufacturer of the machine brings attention to the fact that the lift hoist design does not incorporate gears, pinions and cables, and that, as a result, no large quantity of oil which might soil lumber or other material being carried, is necessary.

Combating Wear of Tractor Parts

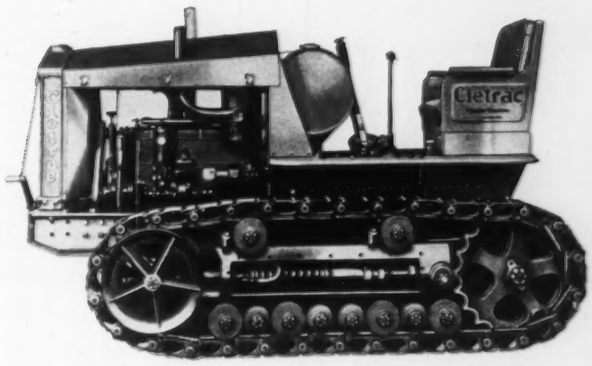


Fig. 1—Side view of tractor with track frame spring and engine exposed

By H. B. Veith
Editorial Representative, Machine Design

OPERATION under power while partially immersed in a mud bath about one foot deep, and running trials in a field pitted with water-logged pot holes, are some of the arduous tests carried out during development of new models of the Cletrac crawler tractor. These tests not only simulate actual operating conditions, but are considerably more severe. Added to the mud bath, for instance, are the most destructive abrasive materials available, including liberal quantities of sand, grit, metal chips and other elements.

Testing of this nature is resorted to by the manufacturers to obtain accelerated results in the endeavor to bring to light possible weaknesses in new designs. After weeks of operation under these exaggerated conditions the machine is disassembled, careful measurements taken, and every effort made to discover wear or other results of abuse on moving parts. If necessary, redesign then can be pushed forward and the tests repeated.

It has been found both from operating experience and from tests that one of the chief problems in the design of the tractor is the provision of adequate seals for shaft bearings and working mechanisms. Probably the most vulnerable spots on the machine, insofar as entrance of dirt is concerned, are the track roller shaft bearings which are mounted in rows of eight beneath the lower faces of the crawler track frames. Considerable difficulty has been experienced in the past in sealing these bearings. In recent designs, however, the trouble has been overcome by adoption of an efficient lubricating system and by use of a special design of seal which retains the lubricant and at the same time excludes dirt. This arrangement is illustrated in Fig. 2.

It will be seen from the drawing that a washer is placed against the end of the bearing box. This washer, of hardened steel, is knurled on the two wedging edges bearing against the packing to insure rotation of the two parts together and thus eliminate the possibility of wear occurring if the washer were allowed to remain stationary and the packing revolved. Bearing against the outer edge of the packing is a flat washer behind which are four coiled springs to

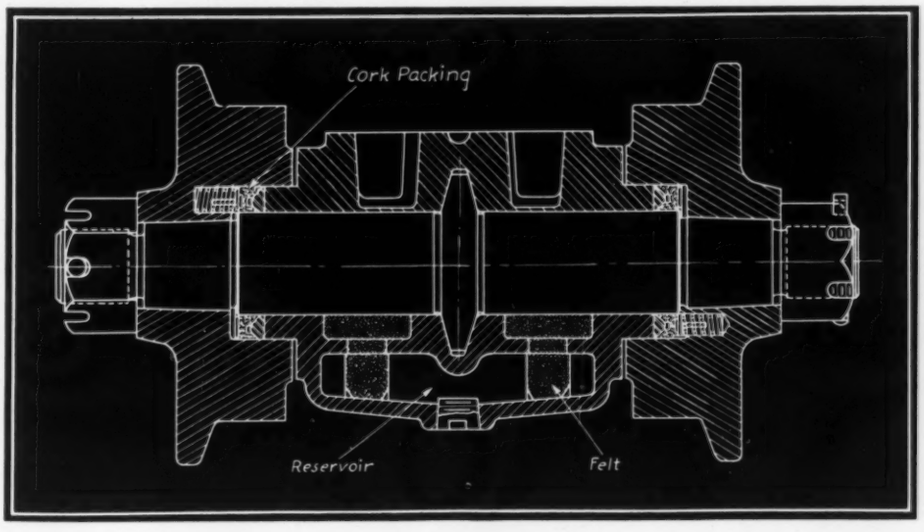


Fig. 2—Cross-sectional view of track roller shaft bearing. These bearings may be partially submerged for hours in sand, grit or other abrasives. Efficient precautions are taken for protection against wear, as evidenced by the packing seal and provision for ample lubrication

apply pressure between the wedge-shaped steel washer and the packing, thereby insuring efficient sealing of the packing inwardly with the shaft and outwardly with bore of the wheel.

Various types of packing material have been used for sealing the track rollers and also the bearings of the main track driving and idler wheels. The most successful material is the cork packing now employed, adapted as shown in the drawing. An earlier method used for sealing the track rollers is illustrated in Fig. 6, but this was discarded due to the entrance of dirt and grit between the faces of the packing and the washer, with consequent breakdown of the former.

In the design of the track frame of the Cleveland Tractor company's model "40-30," a number of changes have been made which undoubtedly will be of interest to engineers in other fields. Fig. 1 shows the track frame, with cover removed, located between the front and rear track wheels. This frame, formerly produced as a steel casting, now is designed for built-up steel construction. The body of the frame is made from $\frac{3}{8}$-inch sheet steel which is formed into a six-sided structure and welded at the joint. Welding also is employed for fastening into place the steel castings which constitute the ends of the frame. This construction is rigid, comparatively simple to produce, and has proved highly satisfactory in service.

Hollow construction of the frame permits without difficulty the mounting of the compensating spring shown in Fig. 1, for the track idler wheel, and the sealing of the spring by means of a closure plate bolted in position. Enclosure of the spring as indicated is highly desirable for operation of the tractor in mud, rocky ground or ice. The spring is employed to provide means for automatic shortening of the center distance between the driving and idler, or rear and front wheels upon which the crawler track runs, this take-up device being essential in case any foreign material becomes lodged between the track and the teeth of the driving wheel or the periphery of the idler. The spring does not exert any pressure on the track to keep it at the proper tension, this being provided for by a screw adjustment on the spring mounting. Undue wear of the track members would take place if the spring exerted constant pressure on the track.

At the rear end of the track frame is a carrier bearing which is used to anchor the frame to a steel shaft bolted directly on the transmission case beneath the driver's seat. The track frame pivots on this shaft, thus allowing either frame to move vertically, independent of the

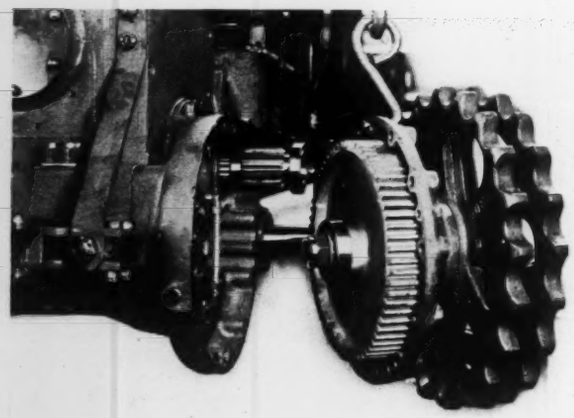


Fig. 3 — (Above) — Track driving wheel mechanism, showing antifriction bearing mounting of pinion and main drive shafts. Fig. 4 — (Right) — Transmission case with cover removed. Oil pipes are from pump at left of case

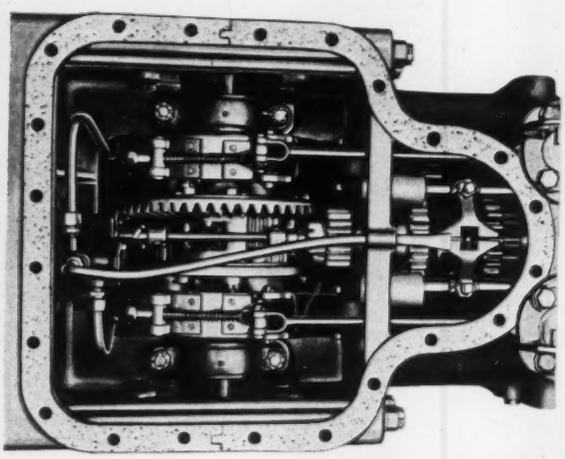
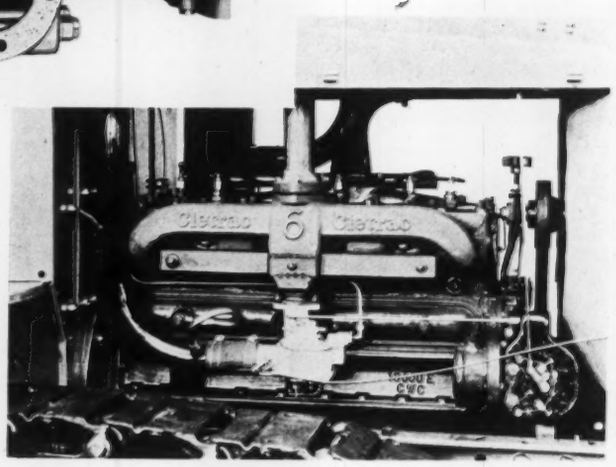


Fig. 5—Side view of engine showing, at left of carburetor, the lead from valve chamber to air induction pipe. This transmits small amount of vaporized oil to gas mixture



other. This feaure is highly desirable as it permits operation of the tractor over uneven ground without throwing torsional strains on the track frames.

Lubrication of all bearings referred to in the foregoing is accomplished by a system developed to meet varying conditions of tractor use. Formerly, completely centralized systems and hydraulic arrangements were employed, but these have been discarded due to the liability of the oil to freeze in the connecting pipes in extremely low temperatures (particularly abroad) and also due to the difficulty of maintaining oil tight joints at the connections. It will be appreciated that such joints would be apt to be especially troublesome in view of the movement of certain portions of the machine relative to each other in passing over rough ground. The later system adopted might be termed semicentralized in that there are only six points to oil in the machine,

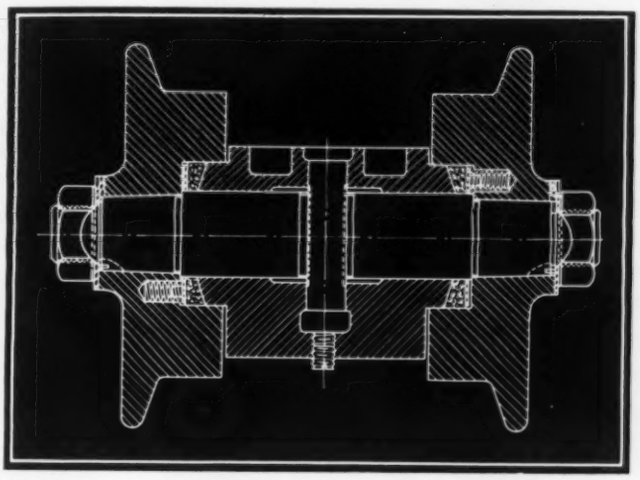


Fig. 6—Early design of track roller shaft bearing now discarded

disregarding the engine and transmission. Of the six points, two are located at the water pump and two at each of the track frames. The latter consist of oil fillers and can be seen in Fig. 1.

Beneath the upper surface of each of the track frames is a reservoir connected by a pipe to another reservoir at the bottom of the frame; the second one is used simply to increase the oil capacity. Both are welded to the track frame and extend throughout its length. From the reservoirs, intended to be filled daily, the oil feeds by gravity through connections to each of the track roller bearings, the front idler wheel bearing, and the track frame shaft bearings. In lubricating the members shown in Fig. 2, the oil passes into a large reservoir in the bottom of the bearing block whence it is carried by capillary action through large wicks to the track roller shaft. This system has the advantage of lubricating from the inside outwards, thus oiling the moving parts and later tending to carry away dust and dirt.

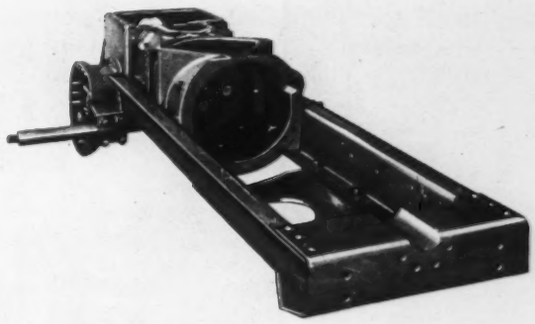
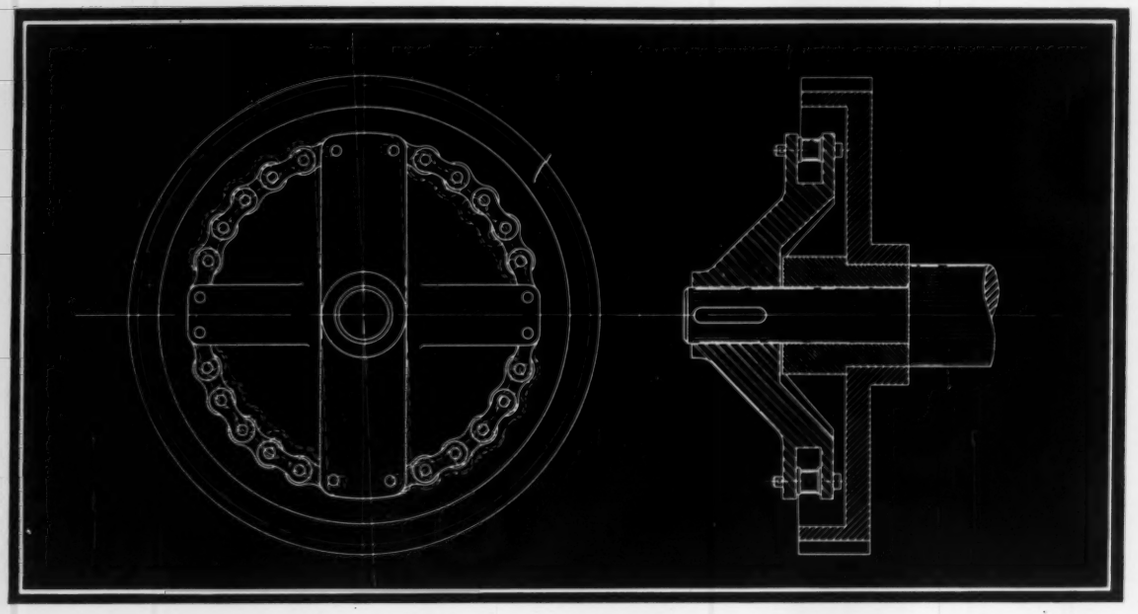


Fig. 7—Engine is bolted to transmission case and rests on pressed steel side frames

The engine is of the standard six-cylinder type illustrated in Fig. 5. To provide adequate lubrication for this unit when the tractor is operating at an angle, front to rear, approaching its maximum of 45 degrees, the main oil pump is augmented by two auxiliary pumps, and oil leads are taken to the front and rear of the well of the crankcase. The transmission gears and differential, shown in Fig. 4, and also the driving wheel bearings are lubricated by a pump located in the transmission case. The fact that the machine, apart from the possibility of working at a steep angle front to rear, may be called on to operate at any angle sideways up to a maximum of 34½ degrees makes it doubly desirable to provide adequate provision for lubrication by a pumping system.

Though the transmission mechanism is in line with automobile practice as far as the gearbox is concerned, there are a number of other features embodied which are of general interest. Chrome nickel gears, carburized, are used, providing three forward speeds and one reverse. Steering is effected through two hand levers at the driver's seat each of which connected with a steering band running around right and left hand drums in the differential mechanism, shown in Fig. 4. Contraction of either of these bands sets the planetary gearing in the differential in motion, reducing the speed of the driving gear at that side and increasing the speed of the gear at the other. The driving gears are connected by splined shafts with pinions meshing with spur gearing on each of the track driving wheels, as indicated in Fig. 3.

Another change in the design of the "40-30," brought about by developments in the art of drop forging and by intensive study of this subject by the tractor designers, is the substitution of steel forgings for the castings used in earlier models for the track shoes. These shoes are subjected to excessive abuse in operation, and the fact that they now can be made as one-piece forgings, even though of decidedly intricate shape, testifies to the ingenuity of the designers of the unit.



Funicular coupling will not co-operate with governor to set up harmonic oscillations

An Unusual Flexible Drive

By H. F. Shepherd

EARLY governors which were weight loaded rather than spring loaded, and pivoted on plain pins instead of knife edges or rolling bearings were more or less insensitive to the variations of crankshaft velocity due to the periodic torque fluctuations of heat engine cycles.

As governors are improved in sensitiveness they show an annoying tendency to dance with the cyclical fluctuations of speed instead of responding only to changes of mean speed. Backlash in valve gear drives due to wear and reversal of torque as cam rollers descend also cause serious disturbances of sensitive governors.

Flexible Coupling Often Is Used

To utilize the rotating mass of the governor as a flywheel which will allow it to rotate at a more uniform velocity independent of cyclical velocity fluctuations, a flexible coupling of some sort often is used to connect the governor to its drive. The oldest of these devices is the rubber-cushioned dental coupling. It is effective but is not durable in oil, and since most modern devices are enclosed and operated under a flood of lubrication it now is passe.

Springs between the jaws of dental couplings also were used a great deal, but this type of drive has a tendency to set up oscillations of its own, the rotating mass of the governor and the coupling springs reacting on each other in harmonic fashion.

Whatever form of drive is selected it should not co-operate with the governor as a mass elastic system to set up harmonic oscillations, and it should not develop backlash in use. It must be as nearly frictionless as possible.

A satisfactory coupling for this work is the funicular coupling shown in the accompanying illustration. A two-arm spider is keyed to the governor shaft. Another is keyed to the governor drive gear or sprocket which floats on the governor shaft. The two spiders are joined by four short lengths of roller or block chain of such length that when the spiders are at right angles to each other the chains form a circle.

When running, the chain loops are held taut by centrifugal force, while the governor by reason of its own flywheel effect tends to run at a constant velocity. If the drive spider velocity is increased suddenly one chain bows out, the other straightens, and vice versa.

The increments of force as the chain straightens tend toward infinity. The decrements of force of the opposing chain tend toward zero, but at a far different rate so that no harmonics are built up.

This device has made operative many good governors that were working badly because of inherent irregularities in the driving velocity.

Problem of Torsional Vibration Increases With Engine Power

By J. Ormondroyd

AS manager of the experimental division, South Philadelphia works of the Westinghouse company, and lecturer on vibration problems at Harvard engineering school, Mr. Ormondroyd is in an excellent position to write authoritatively on the subject of torsional vibration. The accompanying article is the first of a valuable two-section series, the second of which will be published in an early issue of Machine Design.

ENGINEERS are creating more powerful internal combustion engines by increasing operating speeds. At the same time, and partly because of this, the ratio of weight to power is being made smaller and smaller. These two tendencies have emphasized the problem of torsional critical speeds in this type of prime mover. Operating speeds have gone up while natural frequencies have come down and the two have met. Today there are few internal combustion engine systems which do not have at least one dangerous or annoying torsional critical speed in the running range.

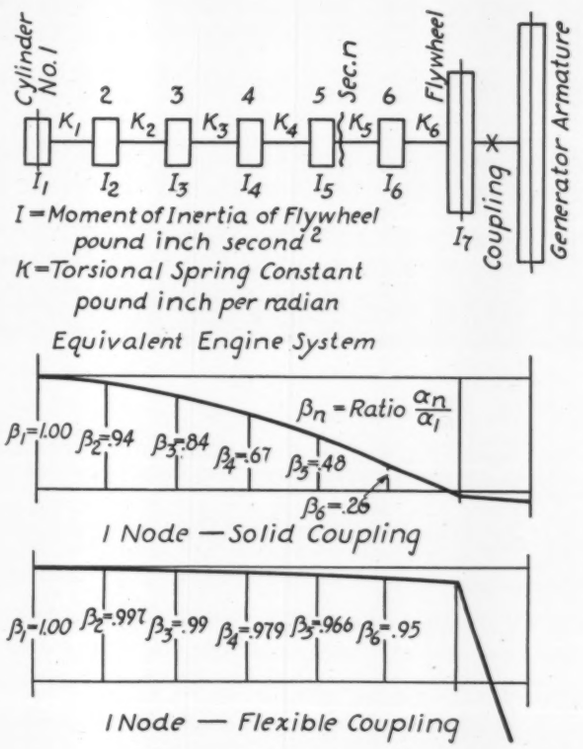


Fig. 1—Idealized six cylinder diesel engine system, and relative amplitudes plotted from Tables I and II

A large section of the nontechnical public knows of the existence of this problem; for nearly all the automobiles offered for sale advertise the use of torsional vibration dampers. The whole world learned of the existence of torsional critical speeds when the GRAF ZEPPELIN dramatically broke four of its five motor crankshafts over Spain. This probably represents the most spectacular full scale fatigue test ever run. The British dirigible "R-101" was equipped with diesel engines which could not run at their rated speed and power because of the existence of torsional critical speeds. It should be stated here that this fact played no part in the tragic ending of the "R-101."

At their worst, torsional critical speeds may lead to broken crankshafts; in their usual manifestation they create violent noises in auxiliary gearing and externally noticeable linear vibrations which lead engine operators to expect destruction.

Remedies Are Proposed

Practically speaking, the problem of torsional critical speeds is a solved problem. It gains the importance it has merely because existent knowledge as to its causes and cure has not been widely disseminated through the ranks of engine designers.

By using certain bold approximations and simplifications, the location of the critical speeds in the running range can be predicted with an accuracy of about 3 per cent. Few calculations in the realm of mechanical engineering can be carried out with this accuracy. The methods used

TABLE I

Elastic Curve and Natural Frequency Based on Equation 2

1	2	3	4	5	6	7	8
	I	$\frac{I\omega^2}{10^6}$	α	$\frac{I\omega^2\alpha}{10^6}$	$\frac{\Sigma I\omega^2\alpha}{10^6}$	$\frac{K}{10^6}$	$\frac{\Sigma I\omega^2\alpha}{K}$
Part	lbs. in. sec^2	lbs. in.	radians	lbs. in.	lbs. in.	lbs. in./rad.	radians
Cyl. No. 1	15	2.175	1.00	2.175	2.175	39	.0558
Cyl. No. 2	15	2.175	.9442	2.050	4.225	39	.1082
Cyl. No. 3	15	2.175	.8360	1.82	6.045	37	.1630
Cyl. No. 4	15	2.175	.6730	1.462	7.507	39	.1925
Cyl. No. 5	15	2.175	.4805	1.045	8.552	39	.2195
Cyl. No. 6	15	2.175	.2610	.568	9.12	31	.2940
Flywheel	435	63.1	—.033	—2.08	7.04	169	.0416
Generator	620	90.0	—.0746	—6.72	.32	42	.0076
Exciter	8	1.16	—.0822	— .095	.225	Estimated value $\omega^2 = 145{,}000$	

When α_1 is taken 1.0000 radians column 4 gives β_n.

Solid coupling shown in column 7 with stiffness of 169 x 10^6 lbs. in./rad.

in these calculations have been published in numerous books and technical magazines. It is not the intention of this discussion to deal with this subject in detail. A partial list of publications on the calculation of torsional critical speeds is given below.*

Proper Design Avoids Critical Speed

The fact that the critical speeds can be located accurately by using the design data of the engine also gives the means of avoiding them by proper design in constant speed engines. Diesel driven generators in small power houses and similar motors which run at a fixed speed always can be designed to operate at a speed sufficiently removed from any torsional critical speed. Even in these cases, elements such as flexible couplings and extra flywheels not usually included in the design of such machines often must be used. Airplane, airship and ship drives might be classified as constant speed engines since a large part of their operation is at predetermined speeds. With these the solution of the problem should be easy. Yet even in this field of constant speed operation critical speed troubles are being experienced. Again let it be emphasized, these troubles are due not to a lack of published information on the subject but to ignorance of the existence of this information.

In variable speed engines such as used on rail cars, locomotives, submarines and automobiles, the problem is more difficult. When an engine may run anywhere in the upper seventy per cent of its operating speed range, the mere accurate location of the critical speeds in that range does not help much. In the modern engine, the designer thinks first of his power output, weight and overall dimensions and takes his critical speeds as they come. The design proportions which are good practice today lead inevitably to critical speeds—and potentially dangerous critical speeds—in the running range.

The same engineers who developed the methods of predetermining critical speeds also proposed numerous remedies. The authors quoted in the foregoing have given several remedies; Holzer and Dashefsky going into the question in some detail. Of all the remedies proposed for the solution of the problem of torsional critical speeds in variable speed internal combustion engine drives, the three most commonly used are flexible couplings, friction dampers, and dynamic vibration absorbers. The principal object of this paper is to discuss these three devices in the light of actual experience in their application. The discussion is pertinent today because these devices are being applied haphazardly with uneven results—success or failure being a matter of chance—when their effects can be predetermined with a high degree of accuracy.

Physical Basis of Calculations

A multi-cylinder engine driving a propeller, electric generator or automobile is capable of vibrating torsionally in several different ways, each with its own natural frequency. In automobile, airplane, and rail car engines of the usual design, with solid couplings between the engine and the driven element, only that type of vibration which has the lowest natural frequency is of any importance. This is the single noded mode of vibration. In larger, slow speed engines, such as used in submarines, the single, two and three noded modes of vibration have been considered important enough for observation.

*Holzer, *Die Berechnung der Drehschwingungen*, Julius Springer, Berlin, 1921.

Wydler, *Drehschwingungen in Kollenmaschinenanlagen*, Julius Springer, Berlin, 1922.

Lewis, *Torsional Vibration in Diesel Engines*, American Society of Naval Architects and Marine Engineers, 1925.

Timoschenko, *Vibration Problems in Engineering*, pp. 138-159, D. Van Nostrand Co., New York, 1928.

Porter, *The Range and Severity of Torsional Vibration in Diesel Engines*, American Society of Mechanical Engineers, 1928.

Dashefsky, *The Elimination of Torsional Vibration*, American Society of Mechanical Engineers, 1930.

Both the true natural frequency and the frequency of maximum amplitude (the frequency which has great importance to designers) could be calculated if complete knowledge existed on the damping properties of the system. This knowledge is still uncompleted. Even under the assumption of simple types of damping, the arithmetical labor involved in calculating the above frequencies is prohibitive. Fortunately the two frequencies of real interest are very near to each other in the usual engine and at the same time they are near to the frequency at which the elastic torques and inertia torques are in complete balance at every instant.

Elastic-Inertia Torque Balance Frequency

Consider the lowest frequency of elastic-inertia balance in the idealized six cylinder engine system shown in Fig. 1 The internal torque balance can be considered without reference to any damping torques and occurs at a definite frequency and with a definite configuration of the system at the instant of maximum twist. By writing down the Newtonian equations of motion for all the flywheels in the system, it can be shown that at the elastic-inertia balance frequency, the following relations exist:

$$\sum_{n=1}^{n=N} I_n\omega^2\alpha_n = 0 \quad \text{(sum of maximum inertia torques in the whole system)} \quad \ldots\ldots (1)$$

and

$$\alpha_{n+1} = \alpha_n - \frac{\sum_{n=1}^{n=n} I\omega^2\alpha_n}{K_n} \quad \text{(relation of amplitudes of adjacent flywheels)} \quad \ldots (2)$$

where

I_n = moment of inertia of body n (Fig. 1)

ω^2 = (2π × frequency of elastic-inertia balance)^2

α_n = maximum amplitude of twist of body n (Fig. 1)

K_n = torsional spring constant between body n and body n+1 (Fig. 1)

$\sum_{n=1}^{n=n} I\omega^2\alpha_n$ = arithmetical sum of maximum inertia torques from body 1 to body n

N = total number of flywheels in system

Equations (1) and (2) make it possible to calculate the correct value of ω^2 and the corresponding configuration of the system at the instant of maximum twist in a "cut and try" manner. Equation (2) does not lead to absolute values of α_n but gives their relative values. Since the twist in the connecting springs is directly proportional to the twisting torque, the frequency of inertia-elastic balance is independent of the actual size of α_n (This remains true within the limits of motion actually found in practice).

Table I shows a sample final calculation based on equation (2) in which α_1 has arbitrarily been taken at one radian. Any convenient value could have been given α_1, but by taking it as one the tabular calculation gives the relative values β_n of the amplitudes directly. Fig. 1 (center) shows the relative amplitudes β_n, plotted from the values given in column 4 Table I for a particular system in which the engine is directly coupled to the shaft of a generator.

Table II indicates the same calculation when a flexible coupling is used between the engine and generator. Fig. 1 (bottom) shows the relative amplitudes for this case. The curves are called "normal elastic" curves for the single noded mode of motion of the system.

When ω^2 has been guessed correctly, the last number in column 6 is zero, satisfying equation (1). In practice this number is considered zero when it is near zero.

Harmonic Energy Input Determines Danger

The normal elastic curves are the basis of the calculations of resonance severity. The relative severity of any critical speed depends upon the energy put into the motion by the exciting torque. As is well known, the explosive method used in creating power in an internal combustion engine gives rise to a constant average torque. Superimposed upon this are a large number of harmonic sinusoidal torques. These latter do no useful work but support torsional

TABLE II

Elastic Curve and Natural Frequency Using Flexible Coupling

1	2	3	4	5	6	7	8
	I	$\frac{I\omega^2}{10^6}$	α	$\frac{I\omega^2\alpha}{10^6}$	$\frac{\Sigma I\omega^2\alpha}{10^6}$	$\frac{K}{10^6}$	$\frac{\Sigma I\omega^2\alpha}{K}$
Part	lbs. in. sec^2	lbs. in.	radians	lbs. in.	lbs. in.	lbs. in./rad.	radians
Cyl. No. 1	15	.1298	1.000	.1298	.1298	39	.0033
Cyl. No. 2	15	.1298	.9967	.1293	.2591	39	.0067
Cyl. No. 3	15	.1298	.99	.1285	.3876	37	.0105
Cyl. No. 4	15	.1298	.9795	.127	.5146	39	.0132
Cyl. No. 5	15	.1298	.9663	.1253	.6399	39	.0164
Cyl. No. 6	15	.1298	.9499	.1232	.7631	31	.0243
Flywheel	435	3.76	.9256	3.48	4.2431	2.5	1.6980
Generator	620	5.365	—.7724	4.14	.1031	42	.0025
Exciter	8	.0692	—.7749	.0536	.05	Estimated value $\omega^2 = 8650$	

When α_1 is taken 1.0000 radians column 4 gives β_n.

Flexible coupling shown in column 7 with stiffness of 2.5 x 10^6 lbs. in./rad.

vibrations. The amplitudes of these harmonic torques can be obtained from indicator card analysis. Wydler, Lewis and Porter have given tables of harmonic torque values for certain types of engines. Fig. 2 gives comparative values of harmonic torques for certain conditions taken from Lewis' analysis. The energy put into a particular vibration is given by equation (3).*

$$W/\text{cycle} = \pi\beta' M a_1 \quad \ldots\ldots (3)$$

W/cycle = energy put into vibration for each cycle of vibration by harmonic torque.

β' = vector summation of relative amplitudes from normal elastic curve.

M = harmonic torque amplitude in one cylinder.

Each different harmonic M varies and so does β'. Methods of calculating β' are given by Wydler and Lewis. Using the values of M given by Fig. 2 and the value of ω^2 from Table I, the relative values of energy input are shown in Table III for the single noded mode of motion. The column marked $M\beta'$ shows relative magnitudes of the maximum energy input per radian amplitude at Cyl. 1 for the various harmonics. Since the particular engine used for illustration has a maximum speed of 900 revolutions per minute, the 6th order is the worst critical with the 4.5 order critical in the same order of violence.

TABLE III

Relative Vibration Energy Input

Order	Harmonic Torque Amplitude M-lbs. in.	β'	$M\beta'$	Resonant R.P.M.
½	35	.65	22.8	7280
1	37.5	.25	9.4	3640
1½	37.5	1.37	51.4	2425
2	35	.25	8.8	1820
2½	29	.65	18.9	1456
3	25	4.19	105.0	1212
3½	20	.65	13.0	1040
4	15	.25	3.8	910
4½	11	1.37	15.1	810
5	8	.25	2.0	728
5½	6	.65	3.9	662
6	4.6	4.19	19.3	610
6½	3.5	.65	2.3	560
7	2.8	.25	.7	520
7½	2.2	1.37	3.02	485
8	1.7	.25	.4	455
8½	1.4	.65	.91	428
9	1.1	4.19	4.60	405
9½	.9	.65	.59	384
10	.7	.25	.18	364
10½	.6	1.37	.82	346
11	.5	.25	.12	331
11½	.4	.65	.26	316
12	.35	4.19	1.47	303

Engine shown in Fig. 1, 6 cylinder, 4 cycle, cylinder area 1 square inch, crank radius, 1", firing order 1-5-3-6-2-4, 1 node—mode of motion as shown in Fig. 2.

If the engine is to run safely in a certain critical speed the damper, vibration absorber or coupling (used as a damper) must dissipate enough energy to keep the amplitude of motion within safe limits provided the natural damping of the engine itself does not accomplish it. The laws of energy dissipation of these devices must be derived by analysis or test.

The proper application of flexible couplings, dynamic vibration absorbers, or friction dampers for the solution of any torsional vibration problem is dependent upon a great many factors which are variable with each installation. The second section of this article will consider such torsional protective devices, and present an outline of the data that must be secured in order to apply them correctly.

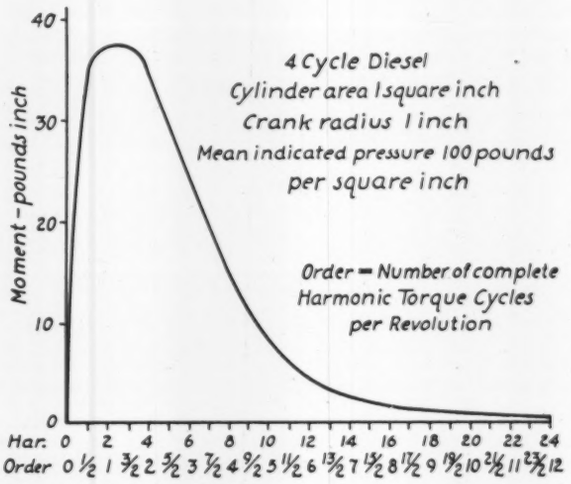

4 Cycle Diesel
Cylinder area 1 square inch
Crank radius 1 inch
Mean indicated pressure 100 pounds per square inch
Order = Number of complete Harmonic Torque Cycles per Revolution
Moment - pounds inch
40
30
20
10
0
Har. 0 2 4 6 8 10 12 14 16 18 20 22 24
Order 0 ½ 1 1½ 2 2½ 3 3½ 4 4½ 5 5½ 6 6½ 7 7½ 8 8½ 9 9½ 10 10½ 11 11½ 12

Fig. 2—Amplitude of harmonic torques versus harmonics

Makes Lubricant of Paraffin Wax

PARAFFIN wax, formerly a troublesome by-product of petroleum distillation, has been converted into a superior grade of lubricating oil. This was revealed recently by a member of the petroleum research committee of the Society of Automotive Engineers. While it has been known for some time that the molecules of the ideal lubricant were made up of two hydrogen atoms and one carbon atom, it remained for a chemist of one of the large oil companies to produce a synthetic lubricating oil having this ideal structure.

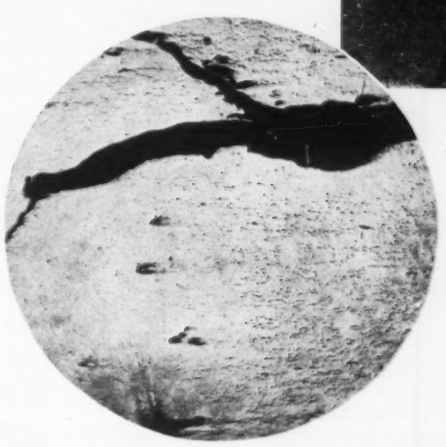
In the natural oils it has been difficult and expensive to secure such "olefines" but new methods of modern research have disclosed a way to crack paraffin and secure an oil of pale straw color, highly resistant to oxidation and capable of standing up under high temperature. Engineers explain that the viscosity can be controlled easily and therefore the new oil is suitable for severe service at either thickening low temperatures or thinning high temperatures.

*Lewis, *Torsional Vibration of Diesel Engines.*

Failure of Machine Members

By L. T. Holt

Fig. 1 (Right)—Crack in crank web which developed from inclusions. Fig. 2 (Below)—Photomicrograph of crack shown in Fig. 1 and of smaller inclusions



WITHOUT doubt the greatest progress of all time in scientific metallurgy has been made within the past decade. Science has delved deeply into the mysteries of metals and, while no one would say that our knowledge is in any measure complete and that the search is ended, so much has been achieved that metal efficiency has been vastly increased.

When the science of metallography was discovered, making it possible to look into the internal structure of metals, a door was opened that revealed endless possibilities. And now, another door has been opened by the X-ray into the study of atomic structure.

The failure of a steel object often presents a most perplexing situation. In some cases, even after the most careful designing by a competent engineer the object suddenly breaks after a comparatively short period of service. The question then is: "What caused it?" The old idea that it crystallized and broke now is known to be a fallacy, as it is impossible for steel to crystallize while cold. The trend today is perhaps to lay too much stress upon pure fatigue when in many instances faulty steel, improper heat treatment, and machining are to blame.

PERPLEXING problems often are presented by the failure of steel in service. Notch fatigue, insufficient heat treatment, and tool marks are considered as some of the principal causes of failure by L. T. Holt, consulting metallurgist, Seattle, in this abstract of a paper presented at the Western Metal Congress, San Francisco.

Some of the principal causes of failure in steel machine parts most frequently encountered are: notch fatigue caused by the formation of internal notches which are formed in turn by massed inclusions of sulphides, silicates and oxides; corrosion fatigue; insufficient heat treatment; and last, but by no means least, rough tool marks left by machining operations and the placing of keyways and fillets in objects subject to extreme vibration and reversal of stress.

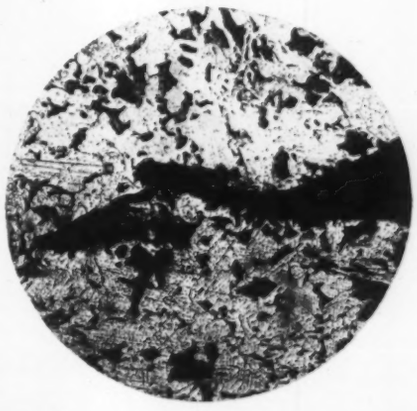


Fig. 3—Magnified view of one of the notches seen in Fig. 2, and the start of a small crack

This brings up the question: "Can it be proved that inclusions of nonmetallic nature, such as sulphides, silicates, oxides, etc., cause failure in steel machine members when subjected to service conditions of alternating and vibratory stresses?"

Shafts always are stressed transversely and subjected to vibration. It is doubtful whether a shaft ever was designed to be subjected to longitudinal stresses. Inclusions would run longitudinally, but stresses would be transverse. In-

clusions have no strength and the space they occupy is of no value to the metal.

After eleven years of service, a large six-throw crank shaft in a diesel engine suddenly revealed cracks that ran half through the section. The engine was of marine construction and, being directly connected to the propeller, the speed of revolution was not great. As the factor of safety was sufficient, it did not seem possible a failure so complete could have been caused by fatigue or sudden shock.

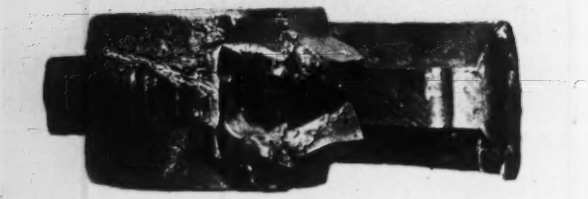


Fig. 4 (Above)—Connecting rod which failed at bolt hole Fig. 5 (Right)—Score marks on the surface of the hole

Test for Tensile Strength

An examination was called for to determine the cause of failure. Tensile test specimens were taken from the broken sections, in both a longitudinal and transverse direction, and also sections for macrographic and microscopic examination. The result of tensile tests were as follows:

Test No. 1, running lengthwise with the shaft:

Yield Point	40,510 lbs. per sq. in.
Tensile Strength	73,840 lbs. per sq. in.
Elongation in 2 inches	29.5 per cent
Reduction of Area	43.5 per cent
Fracture	Irregular

Test No. 2, running across the web, transversely in the shaft:

Yield Point	42,830 lbs. per sq. in.
Tensile Strength	66,860 lbs. per sq. in.
Elongation in 2 inches	24.0 per cent
Reduction of Area	35.6 per cent
Fracture	Irregular, firey, with inclusions

The variations between the transverse and longitudinal test is just what could be expected, an allowance being made in specifications for transverse tests due to the directional properties imparted by forging.

That the tensile test does not indicate the ability of the steel to stand up under stress is proved in this case. Here are two tests, which in a great majority of instances, would be accepted and would fulfill certain specifications for forgings of this class. In making a tensile test a steady load is applied at a uniform rate of speed, but to the shaft in actual service, unequal and sudden loads are applied, some of which may approach closely or even go slightly beyond the elastic limit of the metal.

Internal Notches Hold Inclusions

A section of the crank web close to the pin is shown in Fig. 1, revealing a part of a crack which runs from the crank web to the pin. The specimen was highly polished and etched to develop the macrostructure. On close examination a great number of small notches are seen. These were originally in the metal and were not produced by the etching reagent, which is not an acid and does not produce pits. They are internal notches which were filled with nonmetallic inclusions, some of which were removed by the polishing and etching.

Fig. 2, 50 diameters magnification, shows the end of the crack and a smaller inclusion. In this instance the nonmetallic contents still occupy the notch. The specimen was not etched.

Fig. 6—Photomicrograph of Fig. 5 showing cracks starting at each score mark

A photomicrograph, 100 diameters magnification, of the center of the web away from the large crack is illustrated in Fig. 3. This shows part of one of the notches (seen in Fig. 2) and the start of a small crack. In all the cracks examined, it was seen that each had its start at an inclusion or notch, and the microstructure immediately surrounding or enveloping the inclusion or notch had the appearance of overstressed metal.

In the physical testing of steel forgings and castings, it frequently is observed that the elongation and reduction of area are considerably lower than desired—sometimes to such an extent that these elements are practically nil, although the annealing and grain size are all that could be desired. Upon examination of the fractured test piece, it often is found that there are more or less gaps or small breaks in the strain area of the metal. In faces of this sort, micro-examination would reveal that there were numerous inclusions at this gap and it can be proved that the low elongation and reduction

of area of the test was caused by these inclusions.

Inclusions are known as stress raisers. Their presence develops a highly stressed condition in the areas occupied by them by causing internal notches, and when rupture takes place it is known as notch fatigue. That score marks and rough tool marks also have a definite effect on the strength of machine members subject to stresses of service, has been proved in many instances.

One case of recent occurrence was of a connecting rod from an internal combustion engine which broke off after a short period of service at the wrist pin bearing end. There was a locking bolt hole as seen in Fig. 4. Upon examination of a longitudinal section of the hole, it was observed that it had been scored by the machining operations. Fig. 5 shows that there are many score marks in this radius, and that the large notch had its start at some of these scores.

It will be seen in Fig. 6, a photomicrograph of a section of Fig. 5, that there are four score marks, and that at each is a crack running into the fracture.

Phosphorus Found with Ghost Lines

Dr. Stead has stated that wherever ghost lines are present, a segregation of phosphorus is found. This statement is proved by the etching of suspected areas with Stead's reagent. It has been the writer's experience that wherever ghost lines appeared in steel forgings, sulphides, silicate, and perhaps oxide inclusions also were present.

A macrograph of a section taken at the fracture of a large propeller shaft that failed after a few months service is shown in Fig. 7. While the primary cause of the failure was extreme pitting by salt water corrosion, there was no doubt that the large amount of ghost lines was also a contributing factor. The specimen in question first was polished highly, then etched with Humphrey's reagent of copper-ammonium-chloride, and slightly acidulated with hydrochloric acid for 15 minutes. This action is a mild one and does not pit the metal. An internal crack can be seen running across the ghost lines.

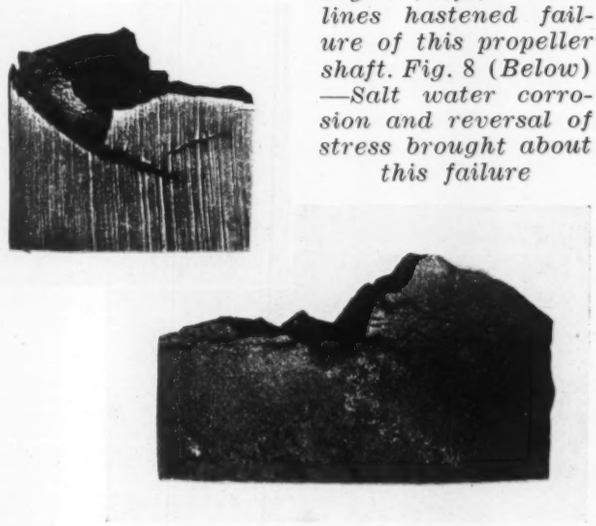


Fig. 7 (Left)—Ghost lines hastened failure of this propeller shaft. Fig. 8 (Below)—Salt water corrosion and reversal of stress brought about this failure

Failure due to salt water corrosion, accompanied by reversal of stress, in a marine propeller shaft in use on a vessel powered by diesel engines is illustrated in Fig. 8. This is part of the fracture and outside diameter. The location is at the propeller end where the shaft was subject continually to the action of salt water.

Fig. 9—Fracture in cast steel whose structure was made up of dendrites of crystallization

Grooves seen in this illustration were caused by salt water attack, augmented by the rotating action of the shaft when in motion.

Motion Intensifies Corrosive Attack

This shaft failed after less than a year of service. It is conceded by all who have investigated the phenomena of corrosive attack accompanied by stress and motion that the corrosive action always is intensified by the motion and stressing. The variation of speed of the ship's propeller, due to the rolling of the vessel, caused unevenness of stress. This, in combination with sea water attack, doubtless was the cause of failure.

An example of fracture in cast steel whose structure was made up of dendrites of crystallization is shown in Fig. 9. This specimen was taken from a large steel casting. Cracks developed on the outside, and an examination was made to determine their depth. At one crack a hole was drilled, part of which is seen at the right of the photo. The specimen was machined out, polished, and etched with copper-ammonium-chloride to develop the macrostructure. The crack starting at the drilled hole is shown running down into the metal. A tensile test proved the metal to be very high in tensile strength and lacking ductility entirely.

Gear Progress Aids Designers

Developments in Gearing Practice Are Discussed by the American Gear Manufacturers' Association

CHARACTERISTICS and design of all types of gears exercise an important influence in development of machinery. In view of this the activities of the recent convention of the American Gear Manufacturers' association at Buffalo, N. Y., are particularly pertinent. The library committee has recommended that the A. G. M. A. practices be disseminated more widely and in this way invite suggestions and criticisms by those not only in the gear manufacturing industry, but who design and specify gears. This, it is felt, will aid the various committees in standardization work.

One of the outstanding papers at the convention covered strength and durability of spur gear teeth and was presented by Prof. Earle Buckingham, Massachusetts Institute of Technology. Errors on gear tooth profiles together with their deformation under load cause the masses on the driving and driven shafts to change their velocities slightly, he asserted. This change in momentum and velocity tends to cause the tooth surfaces to separate, which is resisted by the applied load. After separation the surfaces of the teeth come together again with an impact.

The additional or increment load set up by this impact depends primarily upon the amount of change of momentum in the revolving masses caused by the effective errors in the tooth profiles. On metal gears, where the effective error is primarily the initial error in the tooth profiles and the deformation under load is but a small part of the effective error, this increment load will not be directly proportional to the applied load but will be almost independent of it.

With nonmetallic gears, on the other hand, where the largest part of the effective error is the deformation under load, this increment load may be very nearly proportional to the applied load, Professor Buckingham said.

The type of service under which gears operate is one of the principal factors in determining load capacity, according to F. E. McMullen, Gleason Works, Rochester, N. Y., who reported on the method of computing allowable tooth loads and stresses in bevel and spiral gears. It is essential, therefore, to know if the maximum load is to be continuous, probability of shock, duration of overloads and methods of lubrication. Although accepted as recommended practice, Mr. McMullen's report will be supplemented with additional data covering lubrication, types of mountings, etc.

A paper on photoelastic study of contact stresses in gears prepared by R. V. Baud, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., revealed that as the driving pinion rotates, the contact stresses decrease and the fillet stresses increase. This tendency is a maximum at the point of disengagement, the stress ratio being a function of the load. It was brought out that the load of 20,210 pounds per inch face used in the test is far in excess of the load commonly used in practice.

Keyway Revision Adopted

The proposed revision of the keyway committee, which covers keyways for holes from 18 to 21 inches inclusive, was adopted. The revision is on the 1¾ x 1¼ key for holes 6-9/16 to 7½ inches which was changed to 1¾ x 1⅛ keystock and 1¾ x 9/16 keyway. This is closer to the rule of key height equalling two-thirds of the key width and also lines up with the proposed standard of the American Standards association.

Standardization of small diameter open type worm gears which are being used increasingly will be taken up by the worm gear committee under the chairmanship of W. H. Himes, Nuttall works of Westinghouse Electric & Mfg. Co., Pittsburgh. The group is continuing its experimental determination of the horsepower transmitting capacities of worm gearing to establish a good working formula.

STRENGTH of gear teeth, contact stresses in gearing, and a revision in keyway standardization were highlights of the recent meeting of the American Gear Manufacturers' association at Buffalo, N.Y. In the resume of the convention given in the accompanying article the features of particular interest to designers are discussed briefly.

Standardizing Cylindrical Fits To Simplify Design

By John Gaillard

SPECIFICATION of manufacturing limits of cylindrical parts demands expert judgment of the three main factors involved: the requirements of the manufactured product; the possibilities of the machine shop equipment; and the cost of maintaining accuracy. Fits must be designed so that the final product will function perfectly and have a reasonable life as to wear.

Important from the manufacturing point of view is the question of the manner in which the parts are to be finished. They must be held between the specified tolerance and moreover finished by the most economical process available for the purpose. Shall a certain hole be reamed or broached, or a shaft or pin be turned or ground? This will depend on a number of factors, such as certain details of the design, the nature of the machine equipment available, the size and shape of the parts, the size of the lots in which they are made, and the quality of the surface finish. The latter factor should not be disregarded by the designer. Too often it is assumed that only parts with close tolerances require a high quality of surface.

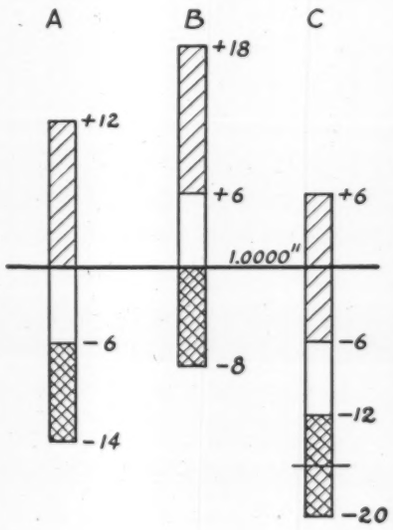


Fig. 1 — Three methods of specifying the same running fits that are identical in character but in which the position of tolerances prevents interchangeability. Tolerances are given in 0.0001-inch

More recently emphasis has been laid on the necessity of giving a good surface finish to other parts, the fit of which is not so exacting. This will prevent the rapid deterioration of surfaces caused by abrasive action of loosened particles during the running-in period. Designers therefore should specify, whenever this is desirable, the kind of a surface finish to be given the parts.

IN view of the present interest in the subject of tolerances for cylindrical fits, the accompanying article is especially timely. Few engineers are better qualified to discuss the matter than Mr. Gaillard, mechanical engineer with the American Standards association.

Only a start has been made in analyzing the quality of surface for the purpose of establishing a standard classification, but much can be achieved in practice by referring on the drawing to samples of surface finishes identified by names or numbers. Sets of such samples should be deposited for reference in the research, engineering, production, inspection, and standards departments.

Accuracy of sizing and quality of surface are related closely to the third main factor which must be considered, i. e., production cost. This goes up rapidly with narrowing of the tolerances and refining of surface quality. Therefore, the tolerances on the parts should be the largest compatible with their satisfactory performance, and the quality of finish should be no more refined than necessary, unless the products demand a higher grade of work because they are, for instance, in the luxury class.

A number of organizations have adopted a series of standard fits of different character cov-

ering the requirements of their products. This simplifies the designer's task considerably by enabling him to select a "ready made" fit and use this on the drawing, designating it by a name or symbol. The latter should, of course, be tied to definite and duly recorded limits for the mating parts, otherwise difficulty will result from varying interpretation by different individuals. What the term "tight fit" or "sliding fit" means will depend in part on the effort spent on assembling the parts. One man may be able easily to slide an external part over the mating shaft, while another may not succeed in doing so, consequently calling the same fit a tight one. Therefore, numerical values for the manufacturing limits of the mating parts always should be the basis for fits specified on the drawings, whether they be indicated by the limits or by names or symbols.

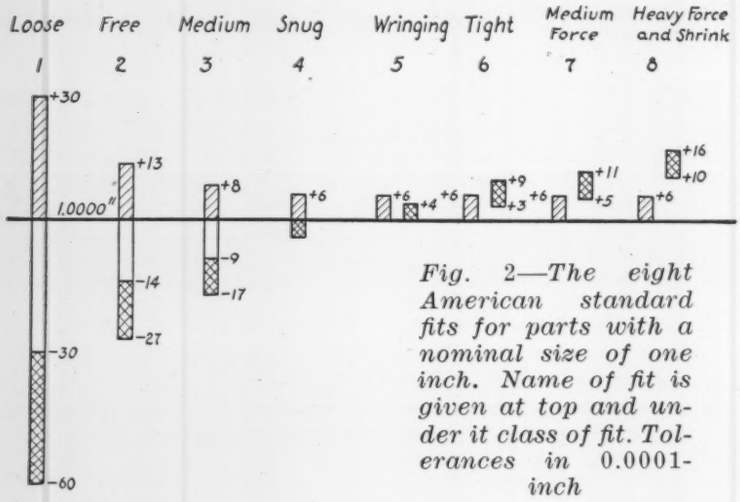


Fig. 2—The eight American standard fits for parts with a nominal size of one inch. Name of fit is given at top and under it class of fit. Tolerances in 0.0001-inch

Additional Requirements Imposed

When interchangeability of fits becomes a problem common to several departments of the same concern, or to different concerns whose respective products must be assembled together, the series of standard fits must answer additional requirements. In fact, fits may be identical in character while still the position of the tolerances relative to the nominal size may prevent interchangeability. This is shown by the diagrams in Fig. 1 representing a running fit specified in three different ways. The cross-hatched bar represents a tolerance of 0.0012-inch on a hole with a nominal size of one inch, while the double cross-hatched bar represents a tolerance of 0.0008-inch on the mating shaft. The allowance (minimum clearance) is the same in all cases: 0.0006-inch. Diagrams *A* and *B* each represent a system of unilateral ("one-sided") tolerances, this is, each tolerance is given from a basic size in one direction only. Diagram *C* represents the principle of bilateral ("two-sided") tolerances, the latter consisting in a permissible plus and minus variation from the basic size of the part concerned. Evidently there is no difference whatever between the way in which the three hole-shaft combinations assemble, but the fit between a hole *B* and a shaft *C* would be too loose, while the fit between a hole *C* and a shaft *B* would be too tight.

All modern national standard systems of fits are based on unilateral tolerances as shown in diagram *A* or *B*, Fig. 1. In the former case, the minimum size of the hole is kept constant and equal to the nominal size. This applies whatever the hole tolerance may be. In such a "basic hole system" the limits of the shaft are varied to take care of the different fits required. This principle has been adopted in a standard now under revision, approved in 1925 by the American Standards association. The eight fits specified in this standard are shown by the diagrams in Fig. 2 for mating parts with a nominal size of one inch. There is a choice between four different tolerances on a hole of a given specific nominal size. For a one-inch hole these tolerances are 0.0030, 0.0013, 0.0008 and 0.0006 inch.

In Fig. 5, a series of fits is represented which is based on the opposite principle, not incorporated in the present American standard. In these fits the maximum size of the shaft is constant and equal to the nominal size, while the limits of the holes are varied to secure different fits. This is called the "basic shaft system." The fits in Fig. 5 are identical in character with those in Fig. 2.

Because the basic shaft system (Fig. 5) does not form part of the present American standard, and fits in this system are needed by some industries, the American standard has been criticised. This and other criticism and the desire to review the standard in the light of recent progress in this field, has led to its reconsideration by a technical committee organized under

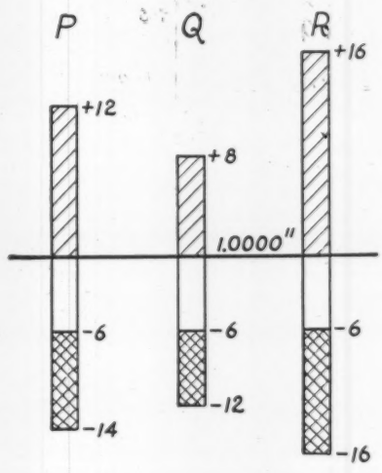


Fig. 3 — Limits are shown at Q and R to which tentative tolerances, P, may be altered in the unilateral system after operation has shown necessity for the change. Tolerance in 0.0001-inch

procedure of the American Standards association. This committee also will consider a proposal for international unification of standard fits now being developed under the auspices of the International Standards association. This

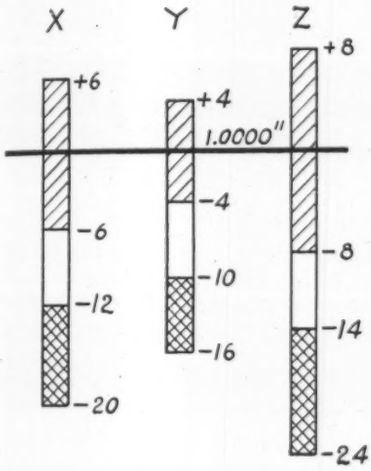


Fig. 4 — More complicated adjustments are required to change tolerances in the bilateral system than in the unilateral shown in Fig. 3. Tolerances in 0.0001-inch

effort aims at the unification of the national standard systems of fits now in existence or in course of development. All of these systems are based on unilateral tolerances as shown in the diagrams of Figs. 2 and 5. While the American and the British standards give the basic hole system exclusively, the other ten existing national standards give both the basic hole and the basic shaft systems. The American committee will consider the addition of the basic shaft system to the standard.

The existence of a national standard is an effective aid to the engineering department. Such a standard must comprise a relatively large number of fits as it must serve the needs of the national industry at large and therefore comprise fits used by concerns making widely varying products ranging from precision machine tools to farm equipment, and from cash registers to railroad cars. Not only is the designer able readily to pick a suitable fit from the national standard series, but also he is assured that such a fit is identical in every respect with that adopted by others under similar conditions.

Far more important to the designer is the fact, however, that he need not give any particular thought to the limits of the mating parts made by other concerns. Take, for example, ball bearings which are often made in large quantities without it being known for what ultimate purpose they will be used. They may go into an automobile, or a drill press, or into the roller of a gravity conveyor. Nevertheless, once the limits of the bore and the outside diameter of the bearing have been standardized*, every user can decide in advance on the limits to be adopted for the mating parts.

From the design viewpoint the unilateral system has a decided and essential advantage over the bilateral in that the former possesses greater flexibility when tolerances must be adopted or revised, especially under the following conditions. Designing a new machine often makes it necessary to adopt the tolerances on certain parts in a tentative way, the use of the machine in actual operation having to show whether they are correct.

Tolerances Easily Adjusted

In Fig. 3, where the diagram *P* represents the original fit, the tolerances may either be reduced to those of diagrams *Q* or increased to those of diagram *R* while still maintaining acceptable fits between old holes and new shafts, and conversely. If bilateral tolerances were used, however, interchangeability between old and new conditions would be disturbed, see diagrams *X*, *Y* and *Z*, Fig. 4. These represent the same kinds of fits as shown in diagrams *P*, *Q* and *R*, Fig. 3, but specified in the bilateral system.

Furthermore, a change in tolerances of the kind mentioned in the example given here, when carried out in the unilateral system, requires a change in only two manufacturing limits: the high limit of the hole and the low limit of the shaft. This is important to the designer as he may have to deal with changes in several fits on the same shaft. Matters then are greatly simplified by the fact that the two innermost of the four limits "stay put" for all of the fits concerned. An addition practical advantage is, of course, that only two, instead of four, limits have to be changed on the drawings.

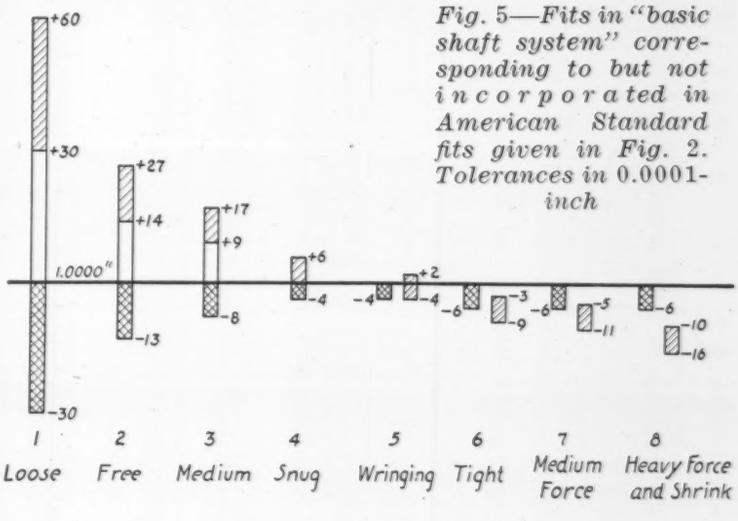


Fig. 5—Fits in "basic shaft system" corresponding to but not incorporated in American Standard fits given in Fig. 2. Tolerances in 0.0001-inch

(*Concluded on Page 66*)

*The main dimensions of the current types of radial ball bearings and the tolerances on these dimensions have become a world standard through agreement between the most industrial countries, such as the United States, Germany, Great Britain, Sweden, etc.

Rubber Compounds in Design

CHEMICAL developments and an improved process of vulcanization have so widened the field of employment of rubber that today it may be applied to scores of uses where it not only will save in cost of equipment, but result in improved performance. Rubber, rubber-fabric, and rubber-metal have established themselves as valuable aids to the designer in combating corrosion, in driving machinery, and in eliminating friction.

NEW uses are being found daily whereby some material may usurp the duties formerly dedicated unqualifiedly to another material. In the accompanying article F. L. Haushalter, B. F. Goodrich Co., details some of the recent developments in the use of rubber by which this material is extending its application to machines.

Compounded rubber before being vulcanized may be warmed up and pressed into the interstices of cotton or other fabrics by passage between the rolls of a calender where a coat of any desired thickness can be applied by adjusting the distance between the rolls. Such fabric then is built up into any number of plies of any desirable shape and, by the process of vulcanization, made into a permanent structure either by applying heat and pressure to a mold or to two plain press platens.

Vulcalock cements have been developed in recent years by means of which a bond as high as 1000 pounds per square inch can be obtained to tie rubber to metal. By this process, rubber has been bonded successfully to cast iron, cast and rolled steel, cast and rolled brass (of limited compositions), aluminum, and some copper bearing steel alloys. Hard rubber also can be combined with metal by a firm bond. Metals may be sealed entirely by the rubber or it may serve as a coat on only one side.

By another process, bonds as high as 600 pounds per square inch may be obtained by curing rubber to brass plated metals. Any type of hot rolled steel stamping can be pickled and plated with a specific composition of brass. The affinity of the rubber for the brass is so great that with many compounds it is not even necessary to apply cement between the two. As a rule, the stiffer the rubber the better the bond.

Rubber vulcanized to metal shells makes a durable bearing for tail shafts of ships, launches and out-board motor boats, or wherever a steady flow of water can be supplied to the bearing. Longitudinal grooves permit passage of abrasive materials through the bearing as well as water for completely wetting the surface. Under these conditions rubber bearings outwear bearings of other materials. In centrifugal pumps handling sand and water, liners to which rubber has been vulcanized, Fig. 3, outwear steel liners about 4 to 1.

Rolls consisting of soft rubber bonded to metal cores or shafts are being made for many purposes. Rolls up to 36 inches diameter and 12 feet long are in use for newspaper printing. In the paper mill industry rolls of various types and grades are used on Fourdrinier machines for making kraft, news, or bond paper as well as on

Fig. 1—Rubber pump liners resist abrasive wear of sand and water and other abrasive mixtures

Find Many Uses

By F. L. Haushalter

Fig. 3—Rubber has been vulcanized to liners for centrifugal pumps for handling sand and water. The two parts of the pump are shown here and on opposite page

cylinder machines. Ringer, waxing and coating rolls demonstrate the practicability of such equipment, the hardness of the rubber used being selected carefully for the service intended.

A 6 by 8 foot ball mill with 1 inch of rubber vulcanized to its inner surface has been in service 2 years grinding silimanite slurry for making spark plugs. The wear on the rubber has been very slight in that time. This same principle has been applied to ball and pebble mills for grinding cores, to rod mills for beating paper pulp, and to ball mills for grinding limestone for Portland cement. In this last application slabs 1⅛-inch thick are held against the mill shell by manganese steel bars that have longitudinal grooves in which the steel balls lodge, thereby relieving wear on the bars.

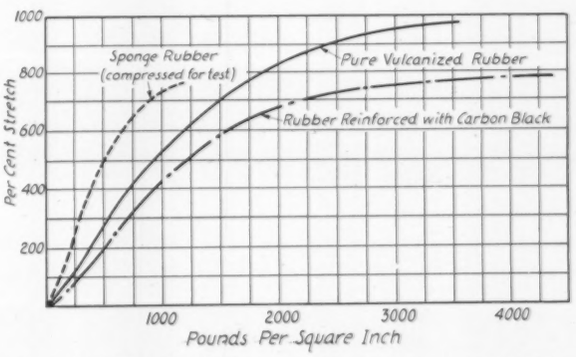


Fig. 2—Typical stress-strain curves of different types of rubber compounds

A rubber bushing pressed between two metal sleeves to form a torsion bushing is finding remarkable success in replacing lubricated spring shackles on automobiles. The rubber in these bushings is in a high state of tension and compression, and will withstand loads as high as 500 pounds per inch of length. Such bushings, Fig. 4, can be applied to various types of oscillating mechanisms such as crawler tractor treads, metal conveyor systems and wicket gates on hydraulic turbines as well as in making airtight joints for liquids and gases. These bushings will take angular movements up to 20 degrees each side of neutral, all the movement taking place in the rubber.

The introduction of a blowing agent, like sodium carbonate, into a batch of rubber during vulcanization forms a cellular structure commonly known as sponge rubber. This material is compressible due to its structure, and the cell size may be regulated by the ingredients of the mixture and by the space the rubber is allowed to fill during the blowing or curing operation. Excellent results have been obtained in absorbing vibration and reducing noise in light machinery by employment of sponge rubber pads under the bases of the machines or between their sections.

Minute rubber particles suspended in water (known as a dispersion) can be deposited electrolytically upon articles of irregular shape, such as wire screens and cage type fan rotors. The coating is deposited uniformly in thicknesses from 0.008 to 0.125-inch and it may be soft or hard dependent upon the ingredients of the dispersion.

Plating racks, numerous types of stacking racks and trays, dipping baskets, lampguards, perforated metal or wire screens for wet screening, and various other irregular metal parts designed for service with corrosive fumes, liquids or other materials, may be protected readily by this process. Fig. 5 shows spinerette tubes, on which rayon yarn is wound, coated in this way.

Hard rubber was discovered by Nelson Goodyear who found that when a relatively large percentage of sulphur was mixed with crude rubber and the mixture cured for several hours, a definitely hard substance devoid of resilience was obtained. The product is commonly known as ebonite. Its range of physical properties

may be expressed in general as follows:

Specific gravity—1.10 to 2.00.

Tensile strength—Max., 10,000 lbs. per sq. in.

Compressive strength—Max., 15,000 lbs. per sq. in.

Transverse strength—Max., 15,000 lbs. per sq. in.

Impact strength—Max., 90 in.-lbs. per sq. in. at 32 degrees Fahr.

Ultimate elongation—1 to 50% (above 20% considerable flexibility is obtained).

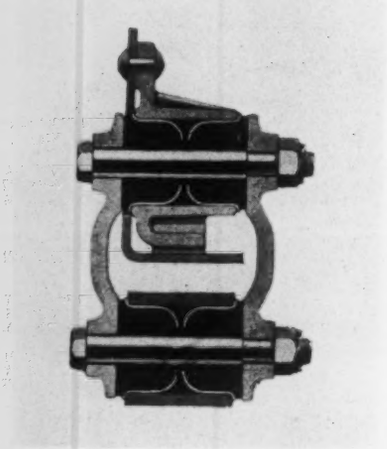


Fig. 4 — Spring shackles on the Graham-Paige have rubber bonded to the metal. No motion takes place between the metal parts, all rotary action being permitted by flow of the rubber

Softening point—Max., 200° Fahr.

Dielectric constant—Min., 2.50.

Dielectric strength—Max., 1000 volts per mil.

Surface resistivity—Max., 18 x 10^9 megohms per sq. in. at 50% humidity.

Coefficient of linear expansion—0.000068 to 0.000088 per degree Cent. at zero degree Cent.

Hard rubber is highly resistant to chemicals such as sulphuric acid (not over 50 degrees Baume), nitric acid (not over 16 degrees Baume), acetic, citric, hydrochloric, hydrofluoric, hydrofluosilicic, phosphoric and other acids, corrosive fumes, oils, greases and kerosene.

By far the greatest field is found in the use of parts molded from, or fabricated with, what ordinarily is called soft vulcanized rubber. The hardness of this material may vary from that of crude to semihard rubber. It is not cellular and is no more compressible than water at practical working pressures, yet it may be made to flow or distort by the application of tension, compression, or shear loads. Such rubber, as usually compounded, has the tendency to recover its original shape whenever the load which has distorted it has been removed. The property of resiliency therefore is associated with this class of rubber goods, although this may vary between wide limits for the range of variously compounded materials coming under this classification.

The technologist must use this knowledge of compounding and comparative testing to formulate recipes in this class to meet the specific requirements of service to which the particular article is to be adapted. The physical properties of this type of material can only be tabulated in an approximate way.

Specific gravity—Min., 0.92 for pure rubber, and max., 5 for rubber compounded heavily with lead.

Tensile strength—Max., 5000 lbs. per sq. in.

Ultimate elongation—Max., 900%.

Resilient to the extent of having a maximum coefficient of restitution of 0.98.

Dielectric strength—Up to 500 volts per mil.

Adhesion to fabric—Max., 35 lbs. per inch width per ply.

Adhesion to metal—Max., 800 lbs. per sq. in. (save working stress about 20 lbs. per sq. in. in shear and 250 lbs. per sq. in. in compression).

Coefficient of friction (wet) of a rubber bearing on smooth steel shaft as low as 0.01 at 1000 ft. per min. and about 0.16 at 100 ft. per min. at 45 lbs. per sq. in.

Pure rubber melts at about 548° Fahr. and chars at about 480° Fahr.

Permeability of pure rubber to gases—Nitrogen as 1, air 1.15, hydrogen 5.5, methane 2.15; permeability varies almost directly as the pressure and temperature.

Coefficient of linear expansion—About 0.00003 per degree Cent.

Rubber frictioned fabric may have a strength as high as 7500 lbs. per sq. in. (safe working stress should be about 300 lbs. per sq. in.)

Soft vulcanized rubber conforms to Hooke's law only at small elongations, and even this proportionality of stress to strain changes upon repeated stretching of the material. About the only way its modulus is referred to by technologists is in terms of stress at a specified elongation, say 300 per cent, this being an indication of stiffness. Typical stress—strain curves to different types are shown in Fig. 2.

In addition to the foregoing properties it is

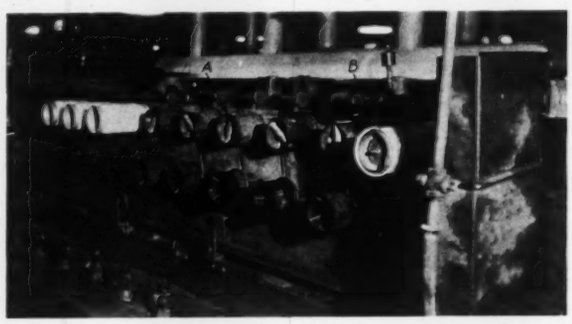


Fig. 5—Spinerette tubes A for winding rayon yarn, on which rubber is deposited

possible that rubber for a specific service may have to be compounded to resist repeated flexing at various speeds, to resist cracking in the presence of sunlight and ozone, both in the stretched and unstretched states, to resist penetration of mineral and vegetable oil products as well as a great number of acids, alkalis and chemical solutions, to resist penetration of X-rays, to resist various kinds of abrasion, cutting, tearing and chafing, and to resist permanent deformation under tensile, compressive and torsional loads; the material also may have to be odorless and lacking in acidity or alkalinity.

Bearings Operate Efficiently at 500 Degrees Fahr.

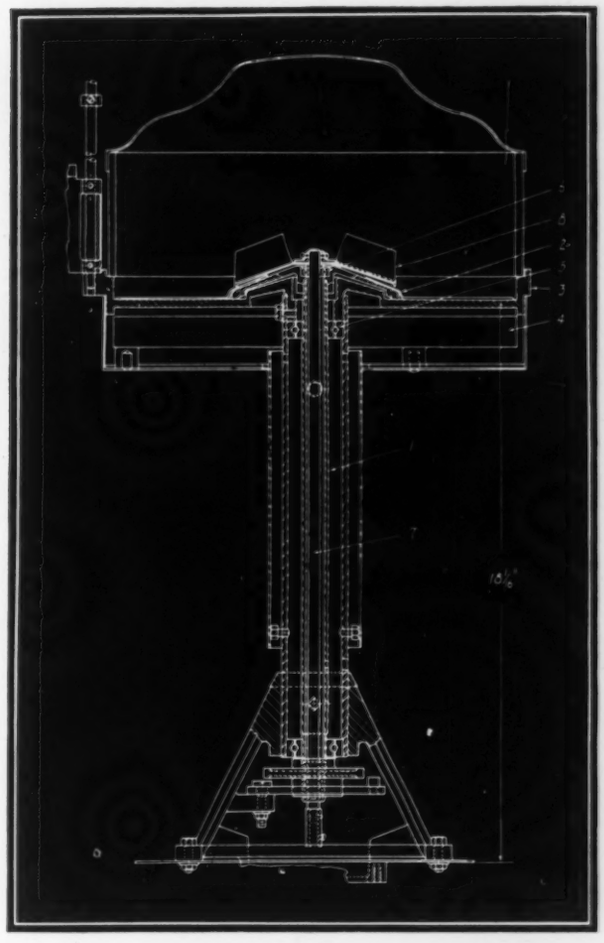
COUNTLESS designs have been brought almost to fruition only to be halted by that age old opponent of the engineer's innovations, "It can't be done!" When this positive statement is irrevocably placed in the way of the design, and when formulas, metallurgy, and past experience prove valueless, there is only one course left for the designer, that of trial and error and proof by long time use.

Such a situation faced W. D. Root, design engineer, Ohio Popcorn Co., Cleveland, as he laid out the details for an automatic popcorn machine.

Bearing Placed in Heating Coil

In this mechanism, a cross section of which is shown in the accompanying illustration, a tubular shaft 1, which turns fingers 2 agitating the popcorn on the hot plate 3, had to be supported by a bearing at its upper end. The only logical position for this bearing was in the center of the heating coil 4, and at this point the temperature is maintained at 500 degrees Fahr. Furthermore, because of the fact that hot butter was used on the plate, and it was imperative that no grease of oil should get into the butter, it was considered necessary that this bearing should not be lubricated, granting that such lubrication could be done by special greases that would withstand the temperature without breaking down.

Many expedients were resorted to in an attempt to provide an efficient bearing that could be installed and left alone for years at a time. These attempts included carbon bearings, oilless bearings and similar devices. Finally an ordinary ball bearing was tried, although the use of this type first was considered entirely out of the question. However, just such a bearing has provided the solution, despite the devastating effects of high temperature and lack of lubrication. A standard ball bearing mounted at point 5, and another installed at 6 where conditions are almost identical, have resisted destructive effects successfully, and a recent examination of a machine put into service two years ago indicated that these bearings have not yet reached the point in regard to wear at which they must be replaced.



Cross section of hot plate on which the corn is popped and of the shafts for driving the fans and agitators

Restrictions Limit Shaft Space

Another unique application of supposedly impossible principles on the machine is the shaft which turns the fans 8, used for blowing the popped corn from the hot plate. Here again were restrictions placed upon the designer. The shaft could not be too large because of appearance, the clearance of shaft 7 in tubular shaft 1 must be as small as possible, and the shaft must not whip, as this would produce vibration, a noisy condition, by rubbing on shaft 1, and resultant difficulties.

It was found that a ⅜-inch shaft, supported only at bearing 6 and by the motor at the bottom, with only 1/16-inch clearance, 18 inches long, and rotating at 8000 revolutions per minute would not whip. The only qualifications were that the shaft be absolutely true and that the fans on the upper end be balanced perfectly.

Taxation of Labor-Saving Machinery Would Stifle Industry

AT LAST the expected has happened. A state representative from an agricultural county in Ohio has proposed a 10 per cent tax on machinery which displaces manual labor. Impressed by the hue and cry that has been raised over the alleged oppression of the machine, he apparently is determined to discourage the development of labor-saving machinery through heavy taxation.

The attitude of this Ohio assemblyman is in direct contrast to that of cotton growers in the South, who far from condemning the machine actually are pleading for a mechanical cotton picker that will work. They want a device that will reduce picking costs so that a better profit can be secured on prevailing low prices for cotton.

One of the greatest boons ever given to American farmers was agricultural machinery which multiplied the number of acres a man could cultivate, thereby establishing the western plains for many years in the role of the granary of the world.

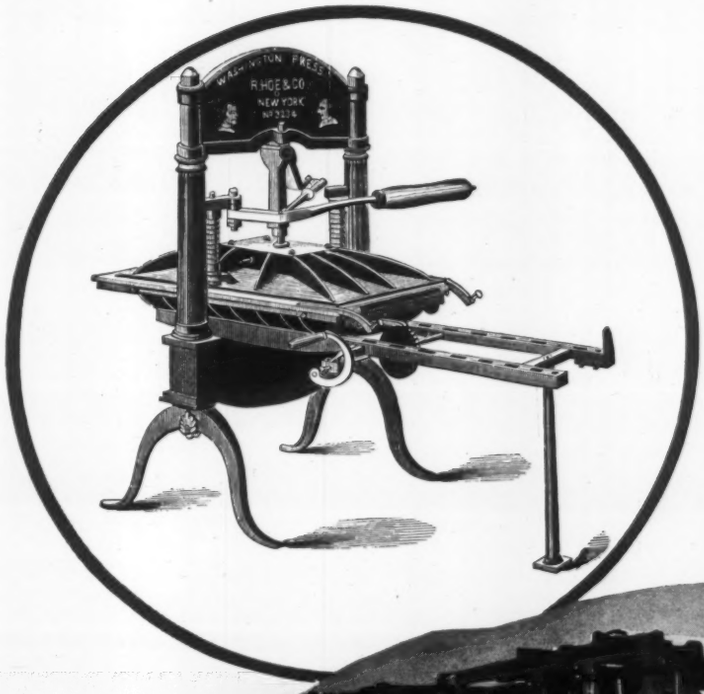
In view of the great debt which agriculture owes to machinery, the attack by the rural assemblyman comes with poor grace. Nevertheless the attitude of the public toward mechanical devices is a force to be reckoned with seriously. The thoughts of the people soon find their way into state and federal legislation, and therefore it is important that representatives of industry and of the engineering profession renew their efforts to educate laymen into a better understanding of the benefits of machines to mankind.

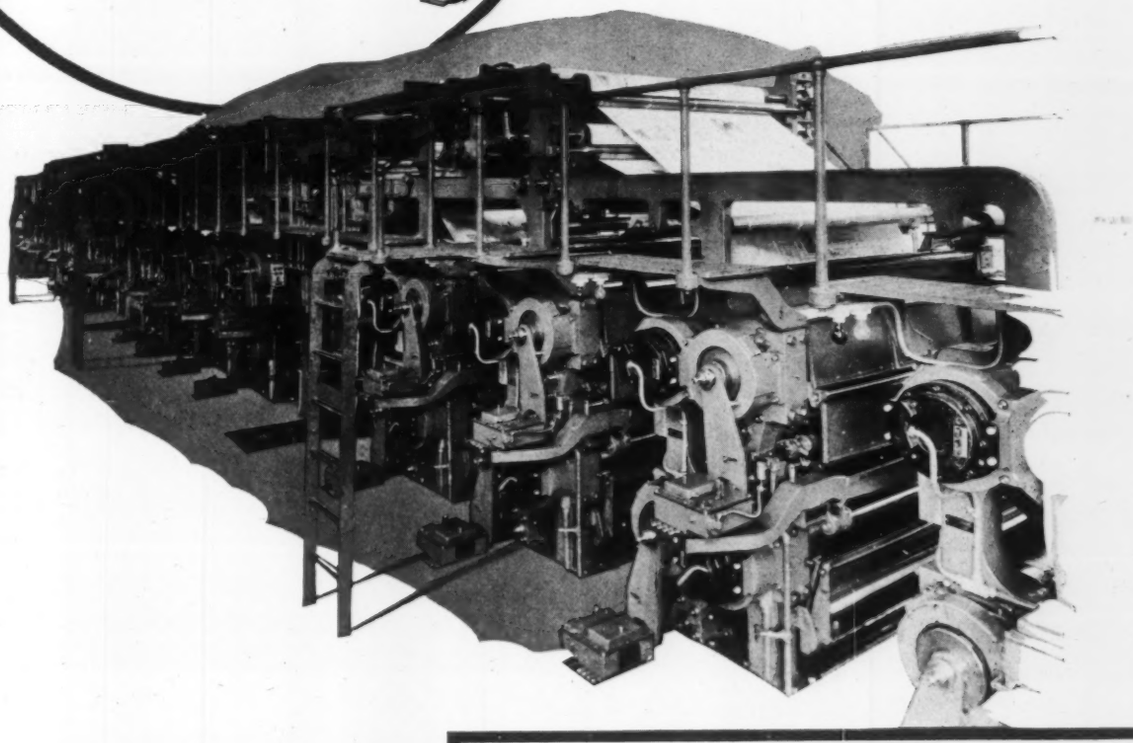
Sales Research Cannot Be Neglected

FAR too many instances are coming to light in which neglect of market analysis has led to serious results in inability to merchandize machinery of various kinds. Engineering staffs often are called on to produce, and in many instances do produce, equipment to specifications arising outside of their department which are not based on sound market data.

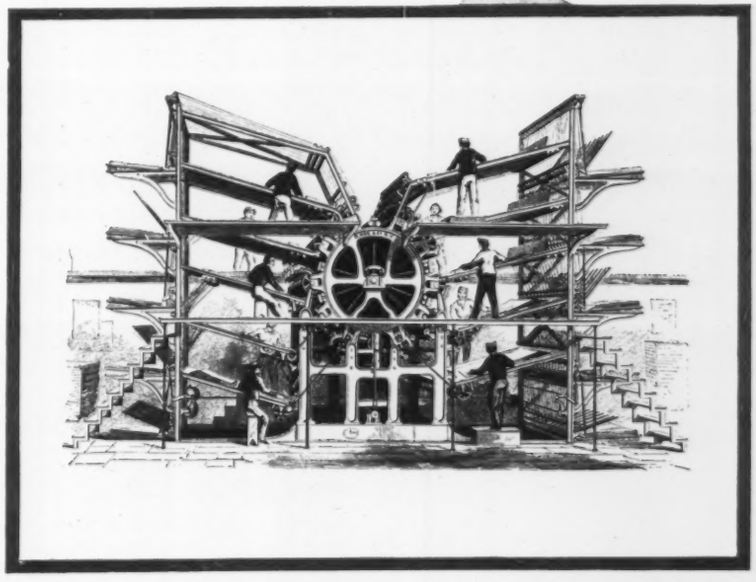
Fortunately many leading companies have recognized this, and to ensure full-time productive work on the part of their design staffs have initiated complete market analysis before proceeding with development of new equipment. Painstaking efforts on the part of designers are fruitless if little opportunity is presented for their machines to sell successfully. The best remedy for this situation is better co-ordination of sales and engineering activities, based always on a bedrock of accurate knowledge of market possibilities.

A Brief History of the Printing Press





Until about 1830, *design of printing presses varied little from original principles laid down by Gutenberg in* 1450. *The Washington hand press, invented in* 1827, *differs in that iron is employed instead of wood, the platen is brought against the type by toggle, lever and spring arrangement instead of by hand screw. By* 1846, *papers were printed on the ten cylinder rotary type revolving press shown at the right. Today the new super-production presses are marvels of mechanical efficiency. Photographs are by courtesy of R. Hoe & Co.*



PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments from Our Readers. Machine Design Will Pay for Letters Suitable for Publication

Will Needle Bearings Gain Headway?

To the Editor:

NEEDLE bearings like all other things have their place. However, I do not think they ever will replace high grade ball or roller bearings, but I do think that in many cases they will replace bronze or babbitted bearings. There are several reasons for this:

1. They do not take up any more room than the bronze bushing or babbitt
2. They are easier running
3. They stay lubricated longer
4. They wear longer due to the fact that they are better lubricated
5. The cost of needle bearings is little more than bronze bushings or babbitted bearings

The needle type of bearing is useful in the replacing of worn out bronze bushings. All that is necessary is to press out the bushing, turn the hole smooth and true, and cut to the proper length, drill rod of the right diameter. The resulting bearing is better than the old bearing ever was. If the old bushing were to be replaced with another bushing, you would have to press out the old bushing, turn up another one, cut oil grooves and scrape the bushing to fit.

Yes, in answer to the article in the April issue of MACHINE DESIGN entitled "Will Needle Bearings Gain Headway?" my opinion is that these bearings will make quite a bit of headway as soon as people learn their advantages and try them out.

—R. A. PERRETT,
Oak Park, Ill.

Revising Engineering Functions

To the Editor:

MAY I offer you my best wishes on the campaign—it will amount to that—you are launching with the excellent article in the May issue, "Shall We Revise Our Conception of Engineering Functions?"

With a resounding broadside you are attacking what I believe is the biggest problem of the age, for the changes you are advocating will of necessity mean such application of engineering principles and engineering forethought to the larger problems of industrial and even national finance, that depressions such as the present one will be extremely unlikely, if not impossible.

But the change cannot, and indeed should not, be wrought overnight, and it will take the continued efforts of many leaders to bring it about and to guide it into right channels.

—JOHN FLODIN,
Minneapolis

Portable Mooring Masts

To the Editor:

I WAS interested in the article appearing on page 26 of the May issue of MACHINE DESIGN relative to the new mooring mast for the Navy Dirigible AKRON. The wording of the last sentence of the first paragraph conveys the idea that whenever airships were landed or grounded in the past, sailors or soldiers were required invariably to assist in this maneuver. I also obtained the impression that this new mechanism will permit the mooring of the airship without the assistance of a ground crew for the first time.

I wish to point out the fact that airships have been moored under power as far back as 1925; this being accomplished at the United States Naval Air Station, Lakehurst, N. J. Here, power driven winches were used when mooring the SHENANDOAH and also the LOS ANGELES to the high mast. The electric winches originally installed were not found to have a sufficient sensitive control for the mooring of airships and therefore Waterbury hydraulic variable speed transmission driven by constant speed motors were added. However, this equipment was not mobile as was the one described in your article, and was used to draw the ship to a mast rather than draw it into a hangar. A mobile stub mast

which was constructed at Lakehurst a few years ago also uses driven winches in which the hydraulic transmission forms an important integral part.

The British Air Ministry employs steam driven winches at the airship base at Cardington, England, but when the mooring mast was constructed at Montreal as part of the British Trans-Atlantic Airship Service they decided to use three winches equipped with hydraulic transmissions. It will thus be seen that airships have been moored in the past without the aid of a ground crew with the exception of a skeleton crew of ten or twelve men to oversee the functioning of the power apparatus, and superintend the landing.

—H. G. Gross,
Waterbury, Conn.

Making Drawings More Readable

To the Editor:

FOR many years draftsmen have been putting dimensions on drawings to read in line with the dimension lines, regardless of the direction these lines took. As a result, a drawing made according to standard practice is read partly while holding it in a normal position, partly while bending the head to the left, and partly by doing a number of other acrobatic stunts to bring the lettering in line.

There is little in the make-up of a drawing that requires the above described method of dimensioning, nor is it justified. It's high time that some Moses came along to lead us out of the wilderness of unnecessary contortions.

A much better method would be one in which all dimensions read from left to right regardless of the direction of the dimension lines. The lines indicate the direction of the measurements, so the figures themselves may be set at an angle with them without causing confusion. It would be interesting to know what other people in the profession think about this improved method of dimensioning.

—Edward Heller,
Cleveland.

Tabulation of Drawings

To the Editor:

THE description of a system of tabulating drawings presented by Mr. Fred L. Burns on page 58 of April Machine Design is a valuable contribution to the literature of design economy in the drafting room and shop. There is a distinct need for such a system in almost every design and drafting room.

On one point, however, I would like to offer a counter suggestion. This is the statement, "The numbers of the bills of materials upon which each part is used are shown, as the information is useful in consideration of changes." To accomplish this, it means that every time an existing part is used on a new assembly the part drawing must be removed from file, have the new bill of material number added, and be reissued as a changed drawing for blueprinting and distribution.

This line of procedure involves a certain necessary cost for handling, drafting and blueprinting which can be obviated by regarding it as a regular standard drawing, thereby eliminating the assembly bill of material and the necessity for reissuing it each time an already detailed part is used on a new assembly. The matter of changes can be handled simply by regarding any desire for change on a part previously detailed and specified as the signal for the creation of a new part number. In this way, changes will not affect existing parts or assemblies, and the matter will be handled in the most direct and expeditious way.

—John F. Hardecker,
Philadelphia

Computing Allowable Roller Pressure

To the Editor:

MANY cases occur in practice where it is desirable to know the maximum load that may be imposed on a roller, the allowable load being taken to be that which does not cause permanent distortion of roller or plate along the element of contact. To determine this experiments were made with a roller 10 centimeters (3.94 inches) in diameter and 10 centimeters long, and the results compared with Hertz's formula in which the brinell number was introduced. If P denotes the load on the roller in pounds, l the length in inches, d the diameter in inches, and H the brinell hardness number, then—

$$\frac{P}{l \times D} = \frac{1}{21.1} H^2$$

H is obtained by dividing the standard load of 3000 kilograms on a 10 millimeter ball in the brinell machine by the spherical surface of the impression made by the ball, expressed in square millimeters. The steel is assumed to have a modulus of elasticity of approximately 3×10^7 pounds per square inch. The results of the experiments accord with the formula derived from calculations.

—William Johns,
New York

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

RE-ELECTION of Prof. C. A. Adams, as director of the American Bureau of Welding marks his twelfth year in this capacity. The action took place at the recent annual meeting of the American Welding society of which the bureau is the research department. Prof. Adams is an engineer of note and at present is Lawrence professor of engineering at Harvard university.

Born Nov. 1, 1868, in Cleveland, he received his technical training at Case School of Applied Science in that city. He was graduated in 1890 and in 1925 the institution conferred upon him the degree of doctor of engineering. During his early career he was designing engineer for Brush Electric Co., Cleveland. He went to Harvard university in the fall of 1891 as an instructor of electrical engineering and a student in mathematics and physics.

During 1919 he was the first dean of the reorganized Harvard engineering school but resigned that post to become chairman of the division of engineering of the National Research council, a connection formed during the World war. Prof. Adams was one of the organizers and first president of the American Welding society. He is consultant for a number of industrial organizations and a member of numerous engineering societies.

NOMINATION of Conrad N. Lauer as president of the American Society of Mechanical Engineers was announced during the recent semiannual meeting at Birmingham, Ala., election to be held by letter ballot of the entire membership. Mr. Lauer, who is president of the Philadelphia Gas Works Co., is author of *"Engineering in American Industry,"* and a contributor to the technical press.

He was born Nov. 25, 1869, at Three Tuns, Pa., and received his education in public and private schools. From 1893 to 1902 he was associated with Link-Belt Co. In 1903 Mr. Lauer became connected with Dodge & Day, engineers, and with their successors, Day & Zimmerman Inc. During the later years of his connection with this organization he served as vice president and director. In 1923 he was Cyrus Fogg Brackett lecturer and he also has been a special lecturer before the University of Pennsylvania.

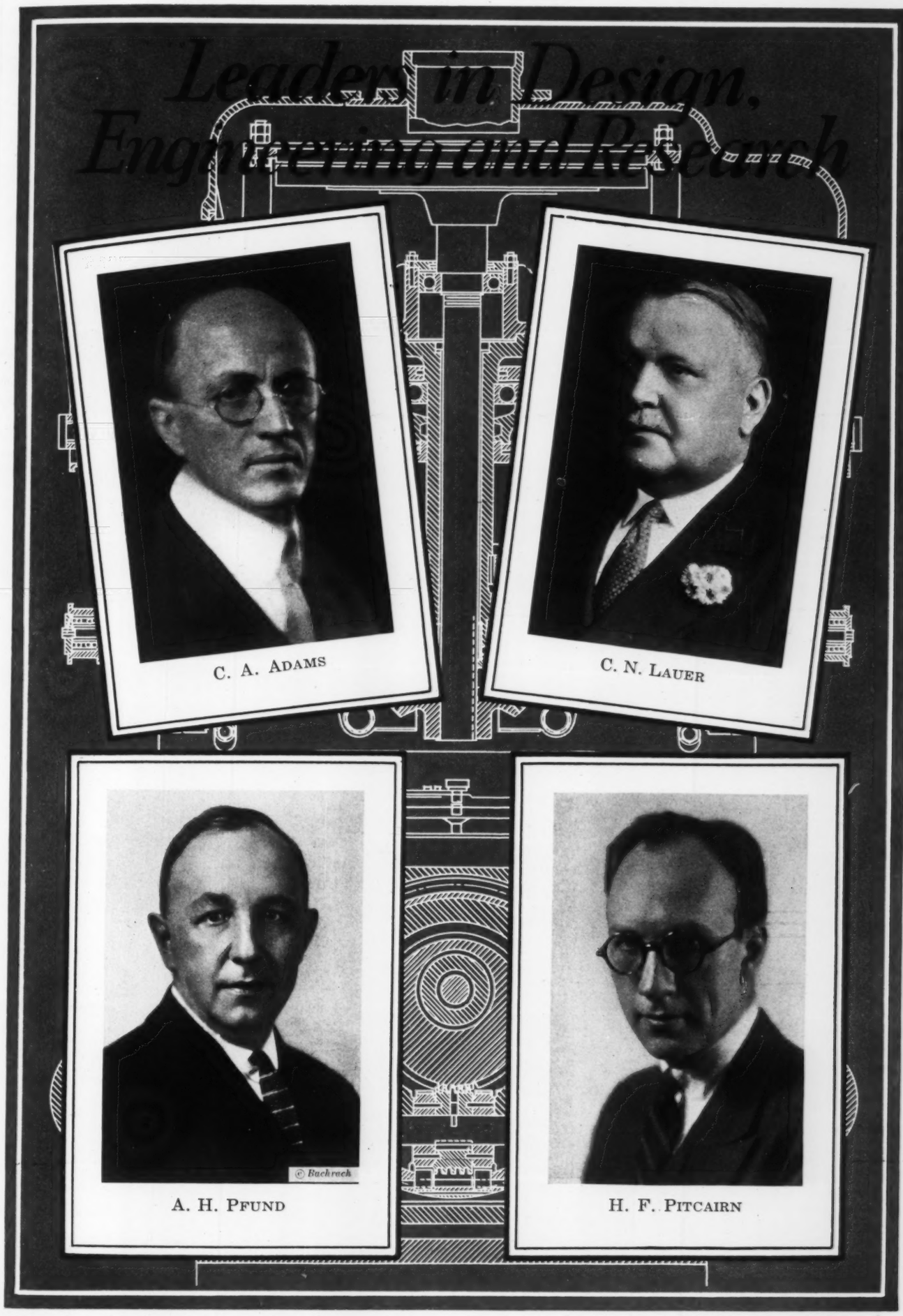
Mr. Lauer has served as a member of the committee on meetings and program of the American Society of Mechanical Engineers since 1922 and was chairman in 1926. From that time he has been a manager and member of the executive committee of council. He was elected vice president of the society last year.

THE Charles B. Dudley medal, established by the American Society for Testing Materials in recognition of meritorious papers on research in engineering materials, has been awarded to A. H. Pfund, professor of physics, Johns Hopkins university. His paper is on "Hiding Power Measurements in Theory and Application," which discusses a rigorous definition of the hiding power of paint.

Professor Pfund was born in Madison, Wis., Dec. 28, 1879, and was graduated from the University of Wisconsin in 1901. That year he was the recipient of the Science Club medal of the institute. After receiving his doctor's degree from Johns Hopkins in 1906 he joined the faculty and since has held the positions of instructor, assistant, associate, and now professor of physics. In 1922 Prof. Pfund received the Longstreth medal of Franklin institute, which is awarded for inventions of high order and for particularly meritorious improvements and developments in machines and mechanical processes.

His interests are largely in the development of technical apparatus and his efforts have resulted in the cryptometer, multiple reflection colorimeter, paint film gage, hardness meter for varnish and other films, gloss meter, and photoelectric cryptometer. Development of the resonance radiometer, light sensitive materials, and infra-red reflection, absorption and polarization has been included in his principal fields of research.

DEVELOPMENT of the autogiro recently won the award of the Collier trophy for Harold F. Pitcairn, head of many allied aeronautical interests centered about Philadelphia. Announcement of the award was made by Senator Hiram Bingham, of Connecticut, president of the National Aeronautic association. It was Mr. Pitcairn who brought to this country the first auto-


Leaders in Design,
Engineering and Research
C. A. ADAMS
C. N. LAUER
© Bachrach
A. H. PFUND
H. F. PITCAIRN

giro which was invented in Spain by Juan de la Cierva in 1928.

Since 1929 Mr. Pitcairn has been concentrating on aerodynamic research and test flying connected with autogiro development, being aided during two visits to this country by Senor Cierva, who came to America for this purpose. Mr. Pitcairn was born June 20, 1897 at Bryn Athyn, Pa., where he always has lived. His experience with airplanes dates back over a number of years. Significant of his foresight in becoming interested in this new type of airplane is the trophy award announcement which declares that the autogiro is "the most revolutionary development in heavier-than-air craft since the first flights of the Wright brothers in 1903."

Other recipients of the Collier trophy are Orville Wright (1913), Grover Loening (1921), and Charles Lawrance (1927).

* * *

B. F. Waterman, engineer with Brown & Sharpe Mfg. Co., Providence, R. I., was re-elected president of the American Gear Manufacturers' association recently. The re-election also included first vice president, E. W. Miller, Fellows Gear Shaper Co., Springfield, Vt.; second vice president, John Christensen, Cincinnati Gear Co., Cincinnati; treasurer, Warren G. Jones, W. A. Jones Foundry & Machine Co., Chicago.

* * *

John M. Lessells, formerly manager of the mechanics division of the research laboratory at East Pittsburgh for Westinghouse Electric & Mfg. Co., has been appointed manager of engineering in the South Philadelphia works. He succeeds A. D. Hunt.

* * *

E. H. Ballard was elected president of the American Foundrymen's association at the annual meeting held recently in Chicago. He is general foundry and pattern shop superintendent of the General Electric Co. plants at West Lynn and Everett, Mass.

* * *

S. M. Kintner, assistant vice president of Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has been elected vice president in charge of engineering. He succeeds W. S. Rugg who now is vice president in charge of sales.

* * *

R. K. Lee has been appointed director of research of the Chrysler Corp., Detroit. He formerly was experimental engineer and has done considerable development along the lines of rubber engine mountings now used on a majority of passenger cars in this country.

* * *

M. B. MacNeille has resigned from Fairbanks, Morse & Co., Chicago, and has joined the sales organization of Dayton-Dowd Co., manufacturers of centrifugal pumps, Quincy, Ill., as western sales manager with headquarters in San Francisco. Mr. MacNeille was for 19 years connected with the pump division of Fairbanks, Morse as designing engineer on centrifugal pumps, chief engineer of the hydraulic division and for the past six years manager of the pump division.

* * *

Otto Lutherer, who for four and a half years has been research engineer at the laboratory of the American Gas association, has been appointed chief engineer in the gas and oil combination equipment division of the North American Mfg. Co., Cleveland. Mr. Lutherer is a graduate in engineering from the University of Berlin and for about a year was identified with the laboratories of the bureau of standards at Washington.

* * *

Cyril Ainsworth has been appointed assistant secretary of the American Standards association, succeeding F. J. Schlink who has resigned.

* * *

Frank L. Eidmann, professor of mechanical engineering at Columbia university has been appointed chairman of a newly formed machine design committee of the machine shop practice division, American Society of Mechanical Engineers.

* * *

F. M. Farmer, representing American Institute of Electrical Engineers and the American Welding society, has been appointed chairman of the American Standards association's sectional committee on electric welding apparatus.

* * *

Capt. Harold G. Bowen, U. S. Navy, has been detached from duty at the navy yard, Puget Sound, Washington, and appointed assistant chief of the bureau of engineering, Navy department. He will report for duty about July 6, relieving Capt. Ivan E. Bass.

* * *

F. O. Clements, technical director, research laboratories, General Motors Corp., Detroit, has been nominated president of the American Society for Testing Materials. S. T. Wagner, consulting engineer, Reading Co., Philadelphia, is announced for vice president.

* * *

G. O. Frostad is in active management of the plant of Krahn Mfg. Co., Milwaukee, filling the vacancy caused by the death of its president, A. W. Krahn. Mr. Frostad formerly was president of Wisconsin National Fibre Can Co., and mechanical engineer for Brooks Machinery Co., where he designed all the automatic machinery it built for the Wisconsin Fibre Can Co.

ASSETS TO A BOOKCASE

Review of Books Pertaining to Design

Mechanized Production

A Philosophy of Production, a symposium edited by J. George Frederick, cloth 259 pages, 5½ x 8 inches; published by The Business Bourse, New York and supplied by MACHINE DESIGN, for $3.00 plus 15 cents postage.

Some aspects of production and the problems of its excessiveness are treated in a well rounded symposium to which such industrial leaders as Owen D. Young, Henry Ford, Walter S. Gifford, Myron C. Taylor, Charles F. Abbott and Henry P. Kendall have contributed. The keynote of the book is struck by Mr. Frederick, the editor, in his statement, "The newer economies of the high wage, mass production, invention, research, the mobility of industry and the swift enterprise of large scale business have cleared a fairly smooth mechanical track between production and consumption; full of difficult grades and curves though it still is, with much still to be desired."

Speaking of the machine age, Mr. Taylor credits mechanical means with having revolutionized the production of materials and in combination with capital and credit resources have inaugurated mass production of practically all the materials essential to life in a way economically unknown hitherto. The volume deals not so much with the purely mechanical side of the situation as the economic and social aspect. However, the cause of the machine provides the background and along with the urge toward more advanced mechanization there runs the problem of increasing consumption. Designers of machinery will find this symposium an absorbing discussion of a question in which they play a vital part.

□ □ □

Design in Agriculture

Agricultural Machinery by Prof. J. Brownlee Davidson, cloth, 396 pages, 6 x 9 inches; published by John Wiley & Sons Inc., New York, and supplied by MACHINE DESIGN for $3.50 plus 15 cents postage.

As professor of agricultural engineering at Iowa State college the author of this book on agricultural machinery is in a position to present the subject from an authoritative technical angle. In view of this the text will be found particularly useful to designers and manufacturers of farm machines. In preparing the work, Prof. Davidson has included phases of mechanics and materials used in construction of machines, and elements of machine design.

A chapter is devoted to transmission of power, in which belting of all types, pulleys, calculations of sizes of pulleys, wire rope, chain or link belting, gears and shafting are discussed under friction and lubrication bearings are treated. Reducing friction by rolling contact is set forth as important practice.

Following a comprehensive explanation of the foregoing subjects the remaining chapters of the book discuss various types of agricultural machinery in descriptive detail. A careful selection has been made of the more important machines in general use in this country and there is no doubt that a careful study of these will be helpful to the reader in understanding others.

In connection with this brief review of Prof. Davidson's book it is interesting to note that he was the author of an article on the design of agricultural machines which appeared in the April, 1930, issue of MACHINE DESIGN.

□ □ □

Slide Rule Manipulation

A Manual of the Slide Rule, by J. E. Thompson, cloth 220 pages, 5 x 8 inches; published by D. Van Nostrand Co. Inc., New York, and supplied by MACHINE DESIGN for $1.75 plus 15 cents postage.

This manual presents an account of the history, principles and practical uses of the slide rule in clear, concise language. Beginning with its relation to logarithmic multiplication and division, the development of the slide rule is explained in the first chapters of the book.

Theory and operation of the Mannheim slide rule follow with reference and review of some of the chief properties of algebraic exponents. Multiplication, division and reciprocals, rules for locating the decimal point, finding squares, cubes and roots, are explained.

Other subjects discussed in a chapter on the modified form of the Mannheim rule include natural logarithms and exponentials, powers and roots, the log-log scale and its use, interpolation and logarithms. Typical problems covering slide rule settings and special forms of the rule are given in the two concluding departments.

NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

POWER transmission through rolling contact between a ball and disks is provided by a unique device recently granted patent No. 1,803,834. This idea was conceived by Mortimer F. Bates, Brooklyn, N. Y., and Sperry Gyroscope Co. Inc., Brooklyn, N. Y., has been made assignee. The principle incorporated in the unit facilitates driving a member in either of two directions from a driving member or ball rotating continuously in one direction. The speed ratio of the drive may be varied.

By referring to Fig. 1, *B* and *C*, the underlying principle can be clearly understood. Drive shaft 10, to the end of which is attached a friction disk 11, is adapted to drive shaft 12 provided with friction disk 13. Driving contact between these two disks is effected by a ball interposed between them, the ball being mounted in a retainer or cage which forms part of an operating carriage 17. Shafts 10 and 12 are offset so that movement of ball 15 inwardly on disk 11 causes it to move outwardly on disk 13 and vice versa.

Disks 11 and 13 are mounted so as to be tangential to the driving ball at points *a* and *b*, subtending an angle as shown at *B*, Fig. 1. In so doing a trough is formed and in operating the carriage 17 in a line parallel to the trough axis, points *a* and *b* described small polar circles as the ball rolls in the trough. By this means rolling contact is employed, thus making it possible to vary the position of the ball with respect to the disks by the expenditure of a minimum of force.

A modified form of the idea shown at *A* and *D* provides an arrangement for varying the direction of rotation of shaft 12 without reversing shaft 10. Spring 25 shown in *A* holds the ball firmly in engagement with the disks. Differing from the design described previously, two disks 13′ and 13″ are provided. These have skew gear teeth around their peripheries and mesh at a point substantially in the central axis of shaft 10. Disks 13′ and 13″ are inclined in opposite directions so that when ball 15 crosses the center of disk 11 to the other side, the ball again will be pressed toward the narrow end of the trough formed by disks 11 and 13′.

By means of the gearing between disks 13′ and 13″, it is apparent that when ball 15 is operated to the other side of the axis of shaft 10, into engagement with disk 13″, the direction of rotation of shaft 12 will be reversed.

IN LAYING out a machine the designer often is faced with the problem of providing some means whereby the speed of the driven element may periodically be retarded or increased while the driving element runs at a constant or uniform speed. This combination has been accomplished in a unique way in a recently patented device shown in Fig. 2.

The principle of operation lies in the application of a continuous chain or flexible transmitter

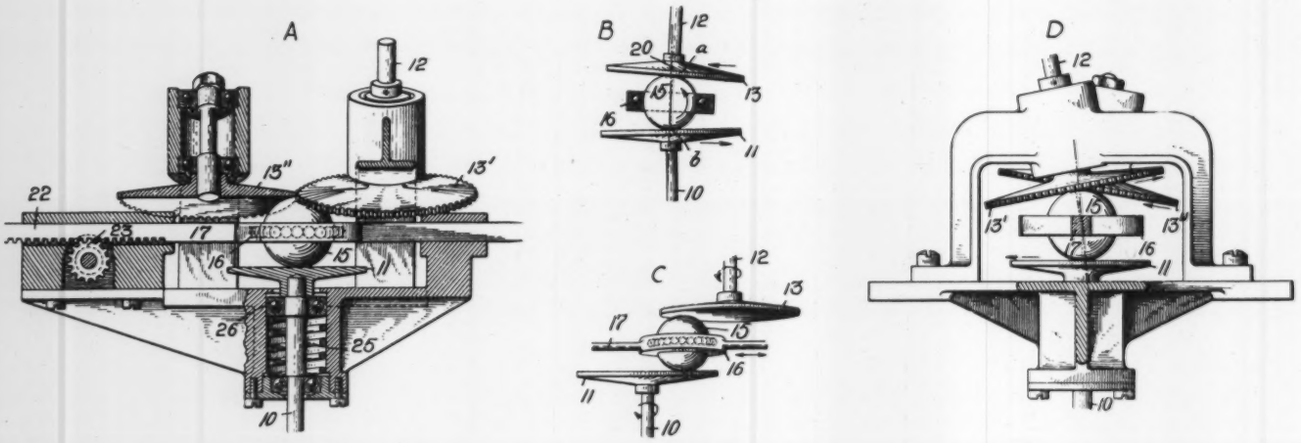
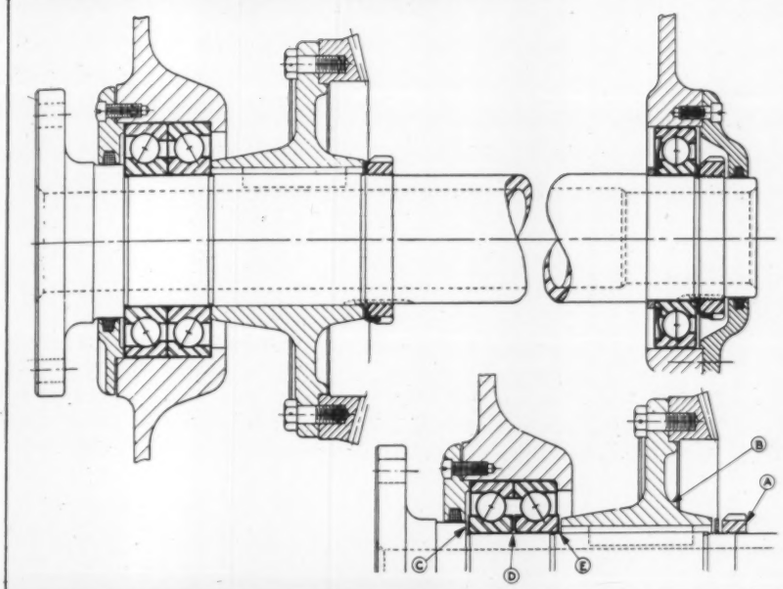


Fig. 1—A—Front elevation of power transmitting device designed for varying direction of rotation of shaft 12 without reversing shaft 10. B and C illustrate principle incorporated. D is an end elevation of A showing angular position of disks

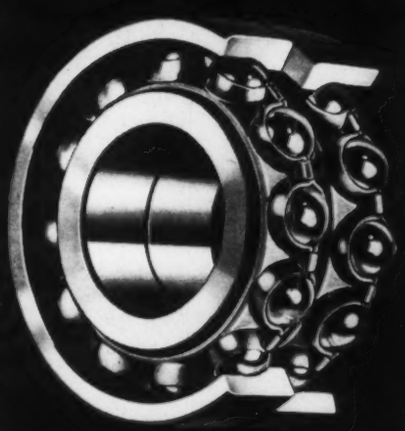
SPEED



Pre-load pressure is applied to this spindle mounting by tightening up on shaft nut "A". Pressure is transmitted through the member "B" to the Duplex Ball Bearing—finally coming to rest against shaft shoulder "C". The gap "D" is ground into the bearing at the Gurney factory to suit the required pre-load. As pressure is applied at point "E" this gap is squeezed together, automatically giving the correct pre-load. Pressure applied beyond this point only tends to lock all parts more securely on the shaft and DOES NOT INCREASE THE PRE-LOAD.

Gurney Duplex Ball Bearings . .

. . . Permit Higher Spindle Speeds with Maximum Accuracy



THE new Tungsten-Carbide cutting tools have radically increased the production and speed capacities of modern machine tools. In these new designs the rigidity of the spindle is given very careful consideration—for it is the maintenance of rigidity under full working load that makes accuracy possible at higher speeds.

Gurney Duplex Ball Bearings may be pre-loaded two to ten times greater than other types of bearings—thus maintaining a high standard of finish at speeds virtually impossible with any other type of bearing.

Under heaviest working loads and at higher speeds the Gurney Duplex is practically frictionless and the running temperature of these bearings remains exceedingly low. For these reasons Gurney Duplex Ball Bearings permit machine tools to take full advantage of modern tool possibilities.

GURNEY BALL BEARING DIVISION
MARLIN-ROCKWELL CORPORATION
Jamestown, N. Y.

GURNEY BALL BEARINGS

and an arrangement to vary automatically the length of either side between the driving and driven elements *a* and *b*, respectively. Although the chain is longer than required for ordinary driving connection, it is kept sufficiently taut by means of jockey pulleys *d* and *e*. One of the pulleys *d* is mounted on a lever *f* which is rocked about its pivot *g* by the action of a rotating cam *h* mounted on sprocket *a*.

The cam arrangement retards the movement of the driven sprocket wheel *b* as the tension is being taken off the chain lying between *a* and *b*, allowing it to shorten. Simultaneously the movement of the driving sprocket wheel *a* then is entirely or in part spent in drawing in or taking up the slack in the chain. On the other hand, while by the action of the cam the slack portion of the chain is lengthened, the motion of the driven member is increased.

The other jockey pulley *e* which acts as a following device, is mounted on a bell crank or level *i* with which is arranged a spring *j* or weight so that the other part of the chain follows automatically the alternating chain shortening and lengthening action the cam-operated lever.

According to the inventors, Laurence S. Harber and John E. Pointon, Peterborough, Eng-

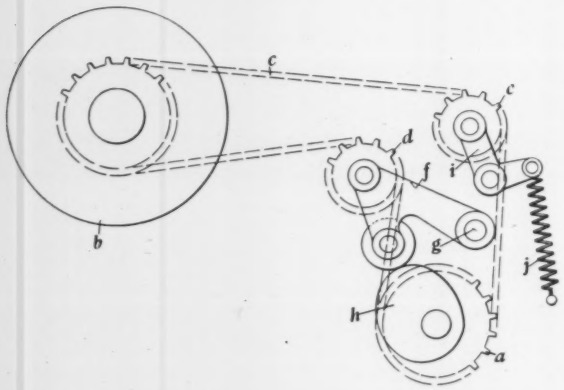


Fig. 2—Variable speed driving mechanism arranged to retard the driven sprocket while driving elements run uniformly

land, the driving and driven elements and also the transmitter and its jockey pulleys may be in various forms to meet different requirements. The patent number of the device is 1,801,043, and Baker Perkins Co. Inc., New York, is assignee.

TO RETARD the movement of a spring driven member, a rotary unit has been devised which pumps oil or other similar liquid through a passageway restricted to set up back pressure and thus counteract the driving force exerted on the driven member. As shown in Fig. 3, gears 14 and 15 intermesh, being rotated through shaft 17 by means of a pinion (not shown) which meshes with driven member 9.

Gear 14 is partially enclosed within recess 22, as is gear 15 in casing 23 which has an extension 24 to provide a partition for separating the liquid beneath the intermeshing teeth of the gears from the remainder of the liquid in the housing. An adjustable needle valve 26 is employed to control the amount of liquid which

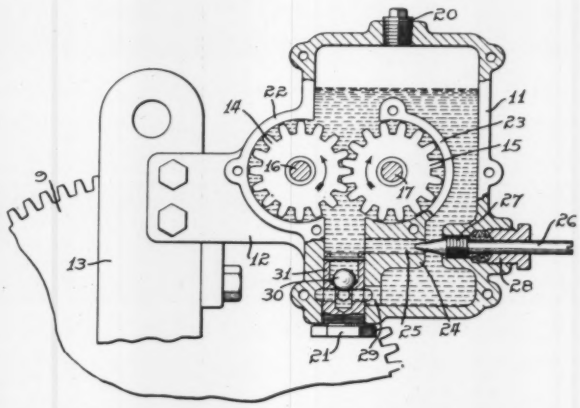


Fig. 3—Retarding device which sets up back pressure to counteract driving force exerted on driven member

may pass through the restricted passageway 25.

In the operation of the retarding device as applied to automobile tire service equipment, which employs a spring motor to reel up an air hose, gears 14 and 15 rotate in the direction indicated by the arrows in Fig. 3. This causes the liquid to be carried downwardly with the gear teeth within the pockets 22 and 23 and to be forced through passage 25, retarding operation of the mechanism. Conversely, when the hose is withdrawn, the gears 14 and 15 rotate in the opposite direction, pumping the liquid upwardly. In order to prevent the pump from exerting any resistance against unwinding the hose bypass 29 and valve 30, are provided.

The retarding device was designed by Joseph C. Woodford, Bryan, O., Patent No. 1,801,032, which recently was granted to him, has been assigned to Service Equipment Co., Bryan.

Review of Noteworthy Patents

Other patents pertaining to design are briefly described as follows:

BEARING ALLOY METAL—1,804,883. A bearing metal consisting of lead hardened by alkali metals and metals of the alkaline earths, containing 0.60-0.65 per cent Na; 0.75-1 per cent Ca; 0.20-0.25 per cent Mg; 0.10 per cent Al; Pb constitutes the main bulk of the alloy. Assigned to Walther Mathesius and Martin W. Neufeld, Berlin-Charlottenburg, Germany.

IMPULSE COUPLING—1,805,598. Covered by this patent is an impulse coupling for magnetos, consisting of an arrangement by which a driven member is adapted to engage a stop lug, and pins on the driving member for disengaging pawls from the stop lug. The driving member is provided with a shock absorbing member seated in a recess. Assigned to Excel Magneto Co., Chicago.

Superior WORMS AND WORM WHEELS *for Any Ratio*

THE frame or casing can be made a part of your design, or our standard frame used, if suitable.

We supply the parts essential to successful operation; efficient, silent running worms and worm wheels, of modern improved type, correctly cut and of the most suitable materials.

You are thus able to incorporate in your machine a silent, compact, speed reducer that is in every way superior to spur gear trains, chain drives or belts.

Our engineers are experienced in speed transformer applications, and will gladly cooperate with you in designing worm gear drives for your machines.

De Laval Steam Turbine Co., *Trenton, N. J.*

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

MECHANICAL processes incorporating new ideas in design of machinery have increased efficiency of operation and resulted in higher output in the mining industry. As to the success of mechanized mining from a cost standpoint, the best comparison is on a tons output per man basis, C. A. Cabell, president, Carbon Fuel Co., told the American Mining congress at Cincinnati recently. The yield in the hand mining system was about 5½ tons per man shift. The present yield for the first three months of this year, after only nine months mechanical operation, is 7.7 tons per man.

Other papers presented gave further proof of the advantages mechanized mining has provided. The designer has played a big part in reducing the drudgery of mining, in addition to developing machinery which has stepped up production and cut operating expenses. Introduction of coal loaders in mines is one example of mechanization that has helped revolutionize the industry. One new machine loads as many as 139 cars or 209 tons in one shift of 8 hours.

At the exhibition of coal mining equipment held in conjunction with the congress, considerable interest was created by the showing for the first time of a coal saw. This unit is equipped with two saw chains driven from a head which can be rotated for vertical or horizontal operation. Spaced about 16 inches apart, the chains extend from the head about 2½ feet and are run over chain guides. The head can be raised and lowered and the machine worked horizontally across the seam of coal, thus cutting blocks approximately 16 inches square by 2½ long, which afterward may be released by means of a pneumatically operated device inserted between the blocks. It is claimed that employment of this type of machine will permit increased production of lump coal.

An indication of competition from abroad was seen in the fact that a Scottish concern took space at the exhibition showing a comprehensive line of mining machinery.

* * *

Start Survey of Screw Thread Practice

APPROXIMATELY 125 manufacturing plants are being surveyed by the American Standards association to determine present practice regarding screw threads. The work is being conducted by the sectional committee on screw threads for bolts, machine screws, nuts and commercially tapped holes, and is intended to provide information for revision of the present standard if necessary.

The investigation will show the actual state of screw thread standardization in the United States at the present time, the range of accuracy desirable for an acceptable product of a given class and the accuracy commercially attainable. A field worker, S. H. Lott, associate professor, department of machine design, Stevens Institute of Technology, will visit 125 plants.

* * *

More Pressed Steel Used in Machinery

PRESSED steel for various machines exhibited at the Leipzig Fair held recently in Germany was indicative of increased use in design. In the electrical equipment division this was particularly noticeable, in many cases the entire frame of small motors being made of pressed steel. On larger motors welded steel plates were used.

Exhibits of machine tools showed construction of welded plates or pressed steel. Employment of these processes in machine construction may represent no savings in cost but the reduction in total weight is important in export trade because it reduces freight charges.

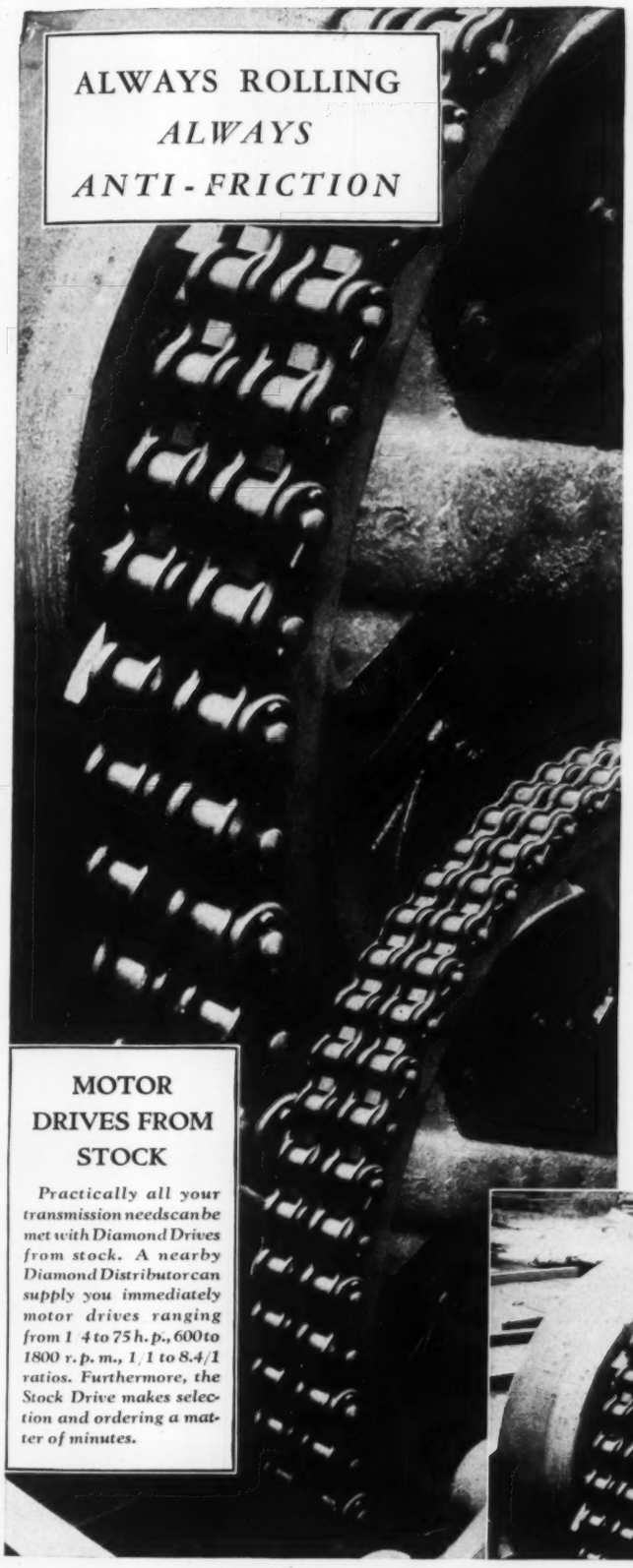
* * *

Design Developments Feature Exposition

MANY innovations in design of machinery used in the chemical and allied industries featured the thirteenth exposition of Chemical Industries held recently in New York. Over 100,000 visitors viewed the 360 exhibits.

Pumping equipment incorporating a number of recent improvements in design was shown. One exhibitor had on display a line of combined vacuum-centrifugal pumps for handling sewage, for pumping the white water from flat boxes in paper mills, for vacuum cleaning and dust recovery. This type of pump also has been employed successfully for moving grain in an English elevator. It is capable of producing a vacuum up to 24 inches, or a compression up to 20 pounds per square inch.

Many types of equipment for filling, sealing,



Step by Step Diamond has developed this "frictionless"* drive

up to 3600 R. P. M. . . . up to 672 H. P.

"NEW" is the term most fitting to the Diamond Drive of today. The roller-bearing, anti-friction principle has been developed to such a point that unequalled durability, surpassing efficiency are available on the highest speeds of which any non-direct drive is capable. And it handles up to 672 h.p.

It excels for economical standardization of drives throughout your plant. Few spare parts need be kept on hand, *no* special tools for repairs. Giving *more* years of trouble-free service, it is positive, never slackens its transmitted speed, never "letting down" production. It curtails space requirements, being narrower, and stronger. And no matter how intricate your drive problems, it provides an easy solution.

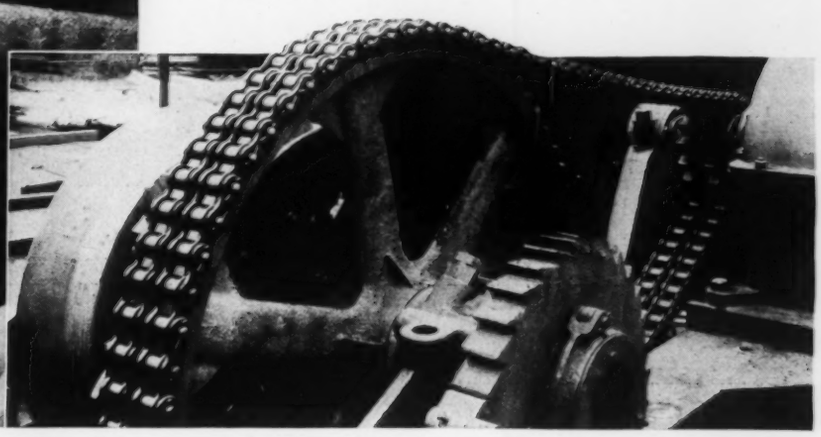
Get full details of this "economy" drive. Send for booklet 102B, "*Reducing the Cost of Power Transmission.*"

DIAMOND CHAIN & MFG. CO.
435 Kentucky Avenue - - Indianapolis, Ind.
Offices and Agents in Principal Cities

*Frictionless by comparison with other positive drives.

MOTOR DRIVES FROM STOCK

Practically all your transmission needs can be met with Diamond Drives from stock. A nearby Diamond Distributor can supply you immediately motor drives ranging from 1 4 to 75 h. p., 600 to 1800 r. p. m., 1/1 to 8.4/1 ratios. Furthermore, the Stock Drive makes selection and ordering a matter of minutes.



DIAMOND ◇ DRIVES for Every Industrial Need

This Diamond on every link identifies the Diamond Chain

NO LET-DOWN IN SPEED AFTER YEARS OF USE

DIAMOND CHAIN & MFG. CO.
435 Kentucky Avenue, Indianapolis, Indiana

Gentlemen: Please send me a copy of Booklet 102B, "Reducing the Cost of Power Transmission."

*Name*_____

*Firm*_____

*Address*_____

*City*_____ *State*_____

(A-4152)

weighing, labelling and packaging were demonstrated. A machine for filling and closing tubes without a clip, an automatic device for blowing bottles clean by compressed air, an improved machine for filling jars with such items as cold cream and mayonnaise at increased speeds and an automatic case-sealing mechanism for bottling, capping and labelling pharmaceuticals were among highlights of the exposition.

* * *

New Engine Developments Anticipated

POPPET valve gasoline engines of both the air-cooled radial and the V-type water-cooled have reached a high stage of development. For this reason, it is not at all unlikely, say aeronautical members of the Society of Automotive Engineers, that the next decade may witness the invention and development of wholly different types of powerplants. During the last ten years the average power output for a given cylinder capacity has almost doubled. There has been an increase of 20 per cent in the mean effective pressures used, rendered possible by an improved valve design and operation by higher compression ratios, improvements in fuel and of combustion chamber design. Rotational speeds have increased 20 per cent made possible by improvements in materials, design and technique of manufacture. There has been a 100 per cent increase in the life of the engine between overhauls.

Experimentation with heavy oil engines has revealed many interesting facts relating to fuel distribution. The application of supercharging also has done much to give an all around increase in power, promising a further method to bring about weight reduction.

* * *

Cornell Offers Administrative Engineering

A NEW course in engineering leading to a degree of bachelor of science in administration engineering will be offered by Cornell university beginning with the academic year 1931-32. This course is seen as a distinct step forward in engineering education and was brought about by the demands of industry for engineers having the requisite training to qualify them for administrative positions in engineering and industrial enterprises.

* * *

To Investigate Technological Unemployment

STUDY of the displacement of men in industry by machines is to be undertaken by a committee of 10 men, several of them government officials, which has been named by Secretary of Labor W. N. Doak. A program of plans and methods of procedure has been outlined. The secretary said that there has never been a satisfactory investigation of what becomes of the men thrown out of work, although some attention has been paid to the scope of technological unemployment. The results of these studies are expected to yield interesting and informing data upon this little known subject.

* * *

To Afford Picture of Engineering Progress

WHEN the Rosenwald museum of science and industry is opened in Chicago next May, a panoramic picture of engineering progress made by science, industry, agriculture, chemistry, transportation, mining and metallurgy will be placed before the public. Features will be a steel mill and cotton gin in operation as well as a full-sized coal mine shaft sunk into the ground under the museum. Visitors will be taken below to see the latest mining developments.

* * *

Mechanization in Agriculture Shows Gain

POPULARITY of mechanization in farming equipment gained over the past year as shown by the use of 14,000 corn picking machines in the state of Iowa alone. One out of every seven acres of corn grown in that state last year was picked by machinery. Corn pickers were used to harvest 1,540,000 acres of the product.

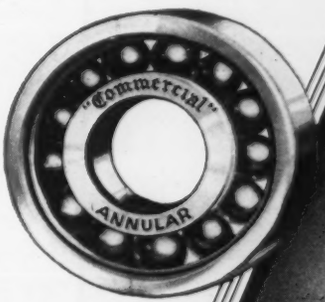
Standardizing Cylindrical Fits To Simplify Design

(*Continued from Page* 47)

The most important point in favor of the unilateral system is, however, that whatever change may be made in a fit, one limit always remains the same: the nominal size. This holds good even though the allowance and both of the tolerances of the fit be changed. The nominal size thus forms a constant reference line, and this fact materially contributes to the easy visualization by the designer while he is considering the values of the manufacturing limits. In the bilateral system, all of the four limits must be shifted with regard to the nominal size with any change in a fit, even when the tolerance on only one mating part is concerned.

Concluding, we find therefore that unilateral tolerances are in every respect preferable to bilateral tolerances in a general standard system of cylindrical fits. The unilateral system is easier to establish, to maintain, and to change. Also, it takes care in the simplest way possible of the numerous cases where parts manufactured by independent concerns or even entire branches of industry must be assembled. This viewpoint has been confirmed in practice inasmuch as all national standards now in existence —twelve altogether—and those in the making, recommend the use of unilateral tolerances. The proposal for the international system of fits now in course of development also is based on the unilateral system.

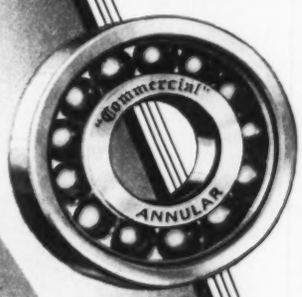
...BRINGING DOWN THE COST OF BEARINGS

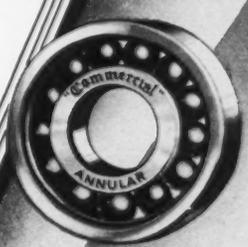


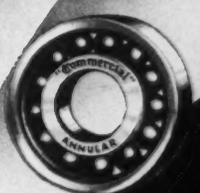
"COMMERCIAL" Ball Bearings are moderately priced. Low manufacturing costs, enormous production of millions of bearings per year, large purchases of raw material, modern machines and methods enable us to make better bearings for less money.

Reduce Your Bearing Costs

Use "Commercials." Let us send you samples and price list. Note the quality. Compare the price. Find out why hundreds of manufacturers use "Commercials." Speeds up to 2500 R.P.M. Famous three-point contact annular ball bearings withstand end thrusts and overloads.





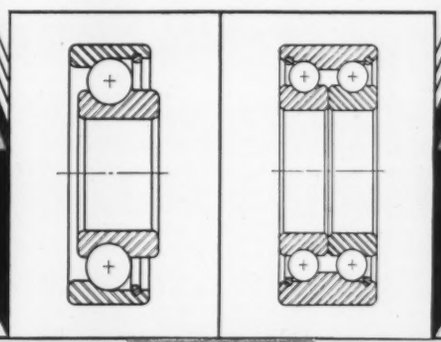


THE SCHATZ MANUFACTURING CO.
Poughkeepsie New York

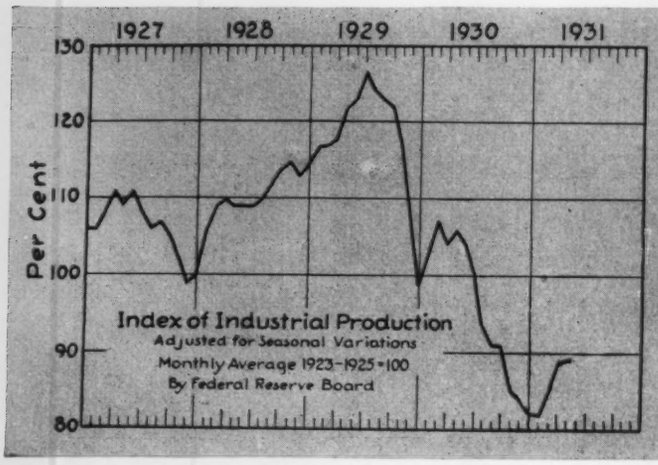
Associated with
THE FEDERAL BEARINGS COMPANY, Inc.
POUGHKEEPSIE, N. Y.
Manufacturers of High Grade Precision Annular Ball Bearings

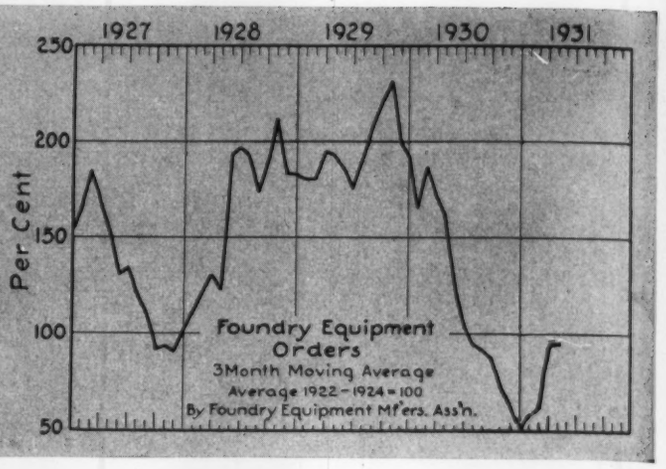
Detroit Sales Office: 917 *Book Bldg.*
Chicago Sales Office: 120 *N. Peoria St.*

TWO TYPICAL INSTALLATIONS



"Commercial"



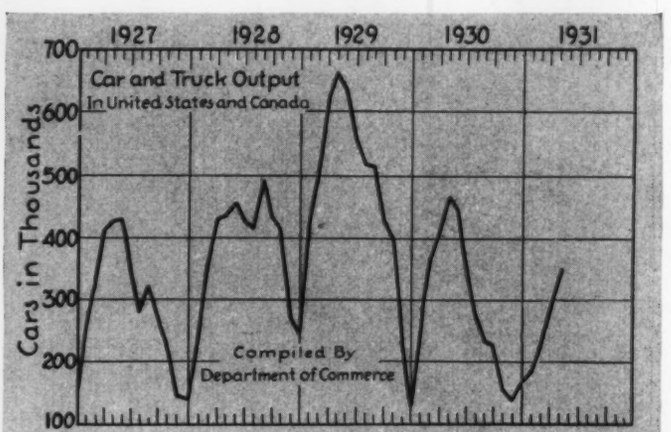


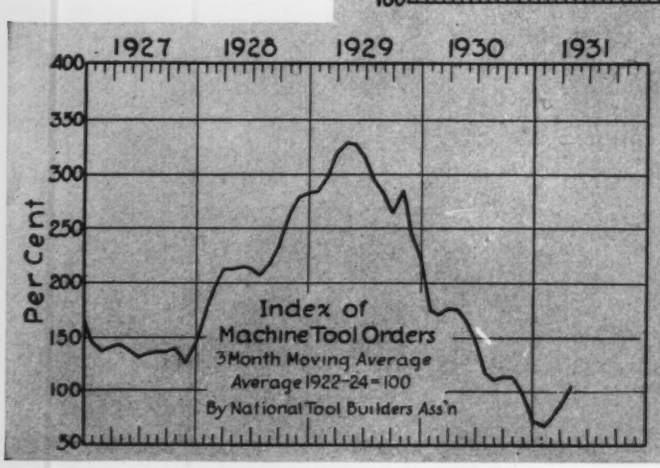
How Is Business ?

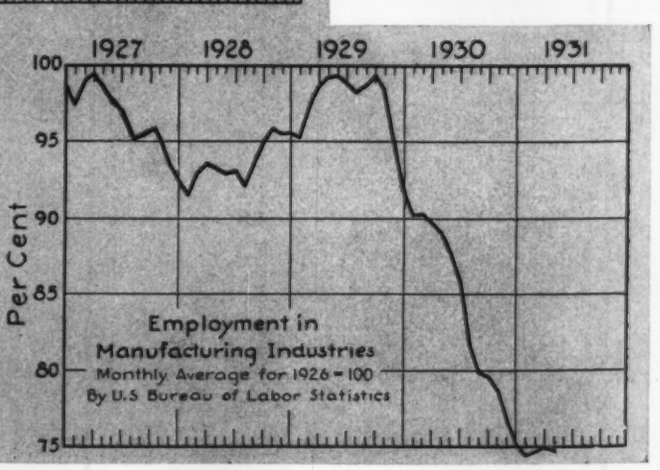
DESPITE encouraging ultimatums of noted business leaders that the bottom point of the depression was passed in December, business staggered in April and was unable to carry the burden of unfavorable times to much advance although it was able to resist further pressure and hold its own.

Although the tonic of spring business apparently produced the greatest advances in March, considerable optimism can be developed over indications of further but gradual improvement. Freight car loadings have shown a surprising resistance to downward trends with April proving to be the best month since last November. As a result of the excellent rainfall and fine weather experienced this year, prospects of favorable farm crops are beginning to be noted in several parts of the West and Southwest with the result that a little more cheer has occurred in the farm implement industry.

No extensive plans for resumption of activity are noted at this time, but sentiment is that some of the important implement and tractor works may see fit to resume at least partial operations by early autumn. It is believed by the National Machine Tool Builders' association that a heavy responsibility rests on management to modernize methods, and so cut costs before cutting wages. Altogether the monthly statistical record shows little evidence that business has begun to slip sideways. It will remain for May barometers to show definite sign of slacking activity.

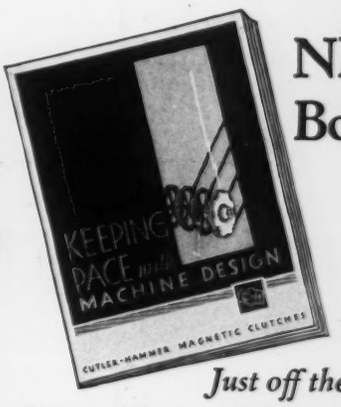






Three Machines in One

C-H Magnetic Clutches permit this cleaning machine to combine the functions of a washer, an extractor and a dryer. Steam pipes, welded into a solid shell, form an interior, revolving cylinder. A slow speed motor rotates this cylinder back and forth through the C-H Magnetic Clutch which is shown in the circle at the top of the machine. After the "washing" is completed, the motor builds up speed in one direction until a C-H centrifugal Governor Switch disconnects the clutch and starts a high-speed motor which now takes up the load through chain transmission. In the drying, the slow-speed motor is again called into play, revolving the cylinder back and forth until contents of the cylinder are dry. Push-button station, control boards, rotating cam limit switch, and centrifugal Governor Switch are also of C-H design and manufacture.



NEW Book!

Just off the press!

If you would keep ahead of your competition in machine design, read this new book. Contains complete revised data on magnetic clutch application. Sent promptly on all requests received on business letterheads. Ask for CL-7, *"Keeping Pace With Machine Design."*

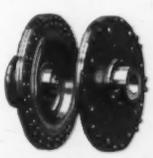
Eternal vigilance *is the key to* sales supremacy

YOURS may be a good machine. But, at the speed machine design advances, where will it be tomorrow? Today's satisfaction is no guarantee of tomorrow's sales. The only assurance of maintained sales supremacy is eternal vigilance—an eternal hunt for improvements, for new features with sales appeal.

Cutler-Hammer Magnetic Clutches are used by more and more manufacturers for this advantage. They present numerous possibilities . . . automatic operation, elimination of unnecessary parts, the reduction of power wastes, the reduction of hand or machine operations.

C-H Magnetic Clutches are the simplest, most trouble-free method of power transmission. They provide such smooth, grabless clutching that machine and motor life are lengthened and maintenance costs are cut to a minimum. They permit engagement and disengagement by means of push button or foot pedal any distance away from the clutch itself. They permit automatic operation by means of limit, pressure, vacuum or float switches or similar devices. They are light in weight and positive in engagement; they eliminate off-center weights, end or side thrust, the need of heavy back-up parts, toggle joints, sliding collars or pivoted arms.

Proven by 25 years of service, serving today on more than 3 million horse power, they merit your full attention. Complete details, interesting applications of C-H Clutches in other fields, are given in the booklet CL-7. Send for a copy.



C-H Magnetic Clutches consist simply of two plates. They are engaged by magnetism, pressure being self-contained. Engagement of driven member with driving member running at full speed is smooth, jerkless, without grab or bounce, without shock to equipment.

CUTLER-HAMMER, Inc.
Pioneer Manufacturers of Electric Control Apparatus
1326 St. Paul Avenue
MILWAUKEE : WISCONSIN

CUTLER HAMMER

Magnetic Clutches Save Time and Save Equipment

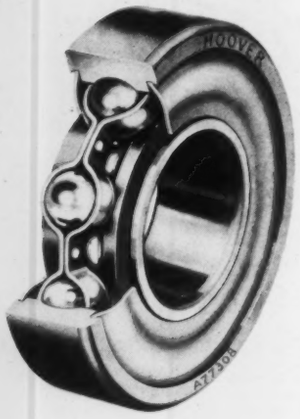
(A-335)

NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Bearings Are Sealed Against Grit

OIL and grease are retained within the raceways, and are kept from leaking to other parts of the machine where lubricants may be detrimental, by stamped metal plates on each side of the raceway in the new double "Ducseal" bearing brought out by Hoover Steel Ball Co., Ann Arbor, Mich. The bearing, shown in the accompanying illustration, is a standard bearing manufactured by the company with plates fitted tightly to the outer ring. These plates remain staticnary with this ring. The other edge

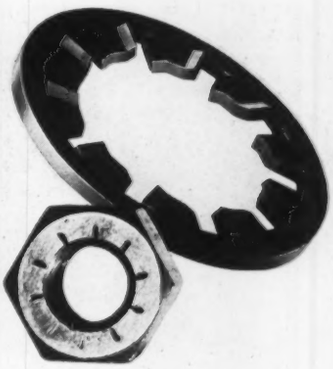


Stamped metal plates on each side of raceway in new ball bearings prevent oil and grease from leaking, and keep out grit and other abrasives

of the plate fits a special groove in the inner ring allowing it to turn freely with the shaft and at the same time maintain an effective seal. The metal plates also exclude dirt, dust, grit and other harmful abrasives from the raceways. The bearings are packed with grease when made ready for shipment. They are available in standard S. A. E. sizes.

Lock Washers Built into Work

DIE-FORMED teeth that bite well into the nut and the work give unusual holding power to the new lock washer announced recently by Thompson-Bremer & Co., Chicago. These "Everlock" washers, shown in the accompanying illustration, have teeth that are hardened and heat treated to the correct temper for the most effective results. Due to the shape of the teeth the lock washer has increased gripping power and holds nuts so firmly that violent

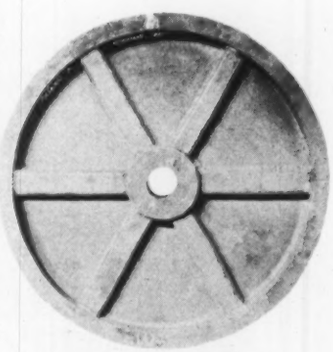


Lock washers dig into the nut and the work as can be seen by impressions left on nut which has been screwed down against it

vibration serves to drive the teeth deeper. The use of these washers gives the advantage of an economical assembly that holds the nut in place and yet can be removed easily.

Fabricate Gear Blanks by Welding

ALL-WELDED rolled steel gear blanks for use in the manufacture of cut gears have been developed and are now being produced by Lukenweld Inc., Coatesville, Pa. These blanks,



Gear blanks are fabricated completely by welding from standard sheet

shown in the accompanying illustration, can be used for spur, herringbone and helical gears, and can be made any size from 24 inches outside diameter up. While they ordinarily are made

Single Close Coupled Type Twin Disc Clutch

TAKES A HEAVIER LOAD..

Six spindles... operating five pieces of work at one time, with different combinations of speeds for the spindles... and the sixth spindle in a position for loading and unloading—that's the Baird Multiple Spindle Lathe.

A Twin Disc Close Coupled Clutch, located on the main driving shaft, drives the six revolving work spindles. The driving mechanism does not set up any side strains on the work spindles or turret. "We are using the Twin Disc Clutch because it will take a heavier load" is *one reason* the makers of this lathe, the Baird Machine Co., Bridgeport, Conn., give for replacing the clutch formerly used.

But, in addition to its greater capacity, the Close Coupled Twin Disc Clutch has remarkable all-around adaptability. The extraordinary simplicity and compactness of its design enable the machine tool designer to incorporate it into special installations, thereby combining unusual efficiency with greater economy. Baird designers, in this lathe, required only a special sleeve to suit this clutch to their individual design.

With a size and type for practically every machine tool need—2, 2½, 3, 3½, 4, 4½, 5, 5½, 6, 7, and 9 in. effective diameters; oil or dry plate, single or duplex—the Close Coupled Twin Disc Clutch may effect a considerable saving for you. *Write* our Engineering Research Dept. for specific recommendations. Engineering Data Book on request. *Twin Disc Clutch Company, 1325 Racine St., Racine, Wisconsin.*

TWIN DISC CLUTCHES

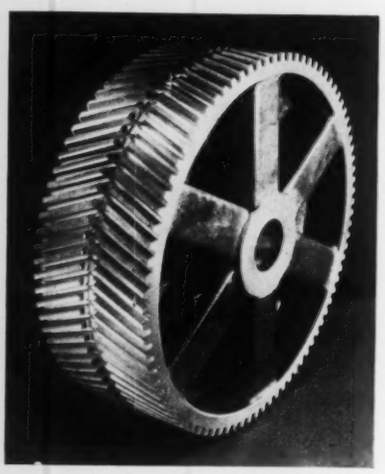
entirely from S. A. E. 1020 carbon steel, the rims can be furnished in steels of special analyses if desired.

The hubs of the blanks are first cut from solid rolled steel of the thickness to give the desired diameters. The webs are cut from rolled steel plate, as are the ribs, the latter being formed into channels of the required section. Webs are arc welded to the hubs, and the reinforcing channels are welded to the web structures. The final operation consists of the circular bending of the gear ring, and welding it in position to form the finished gear blank. Before shipment, all of the blanks are annealed under pyrometric furnace control.

Rolled steel such as used in these blanks, on which a patent has been applied for, is characterized by marked freedom from blowholes, gas pockets, hard or spongy spots and other defects. The gear rings, therefore, can be cut uniformly and the cut teeth are sound in structure.

Welded Gears Develop High Strength

FREEDOM from blow holes and casting strains is afforded in the new "Philweld" gears which are manufactured by Philadelphia Gear Works, Philadelphia, from rolled and forged steel fabricated by welding. In the gears, shown in the accompanying illustration, the rim is cut in the form of a solid ring from 1040 S. A. E. rolled steel plate. A solid rolled steel disk forms the web of the gear, against which channel shaped arms, die-formed from heavy plate, are welded to both sides.



Rolled and forged steel fabricated by welding are used to construct gears of all types

Either four or six arms are used according to the size of the gear. In small sizes, the web is of sufficient strength to require no additional reinforcement. The hub is a forged steel bar drilled to receive the shaft. Hub, arms, web and rim are welded into an integral structure and then normalized before machining to insure permanent accuracy.

The gears are balanced, every component part being rolled and cut to precision before being welded into the finished part. They are made in sizes from 15 to 168 inches, in spur, internal, helical, bevel, herringbone, and other types. The built-up gear is about 10 per cent lighter than the usual type gear.

Starters Are Reversed Magnetically

REVERSING is accomplished by means of two mechanically interlocked magnetic contactors which are controlled from a remote point in the new across-the-line type reversing starters for direct and alternating current polyphase motors up to three horsepower announced by Cutler-Hammer Inc., Milwaukee. These new starters are designed for use with motors on hoists, lifts, small machine tools and other equipment where a half time, intermittent duty reversing starter is required.

Small size and high operating efficiency features across-the-line type reversing starter

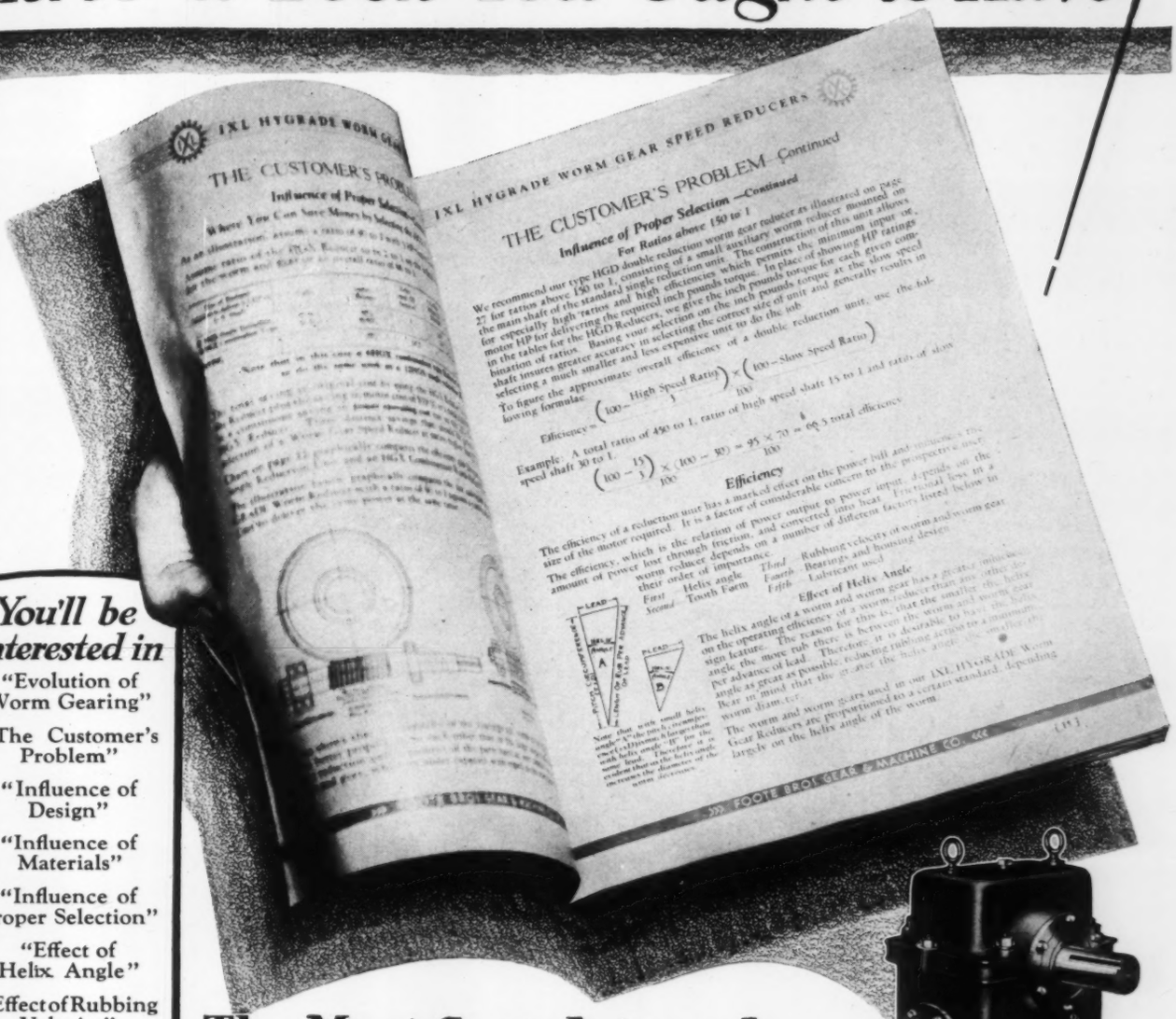
Small size and high operating efficiency are features of this new starter, shown in the accompanying illustration. The contactors are a new three pole design, while silver to silver contacts reduce arcing and pitting to a minimum and assure maximum current-carrying capacity at all times. The magnet structure consists of a laminated frame with a shading coil for alternating current and a brass shelf for direct current.

These starters are furnished in two types: Type SRA is arranged for two-wire control only. It has a maximum capacity of 1 horsepower. Type SRB can be used for either two or three-wire remote control. Blowouts are provided to give maximum capacity of 3 horsepower.

Electrode Will Weld Special Steels

AN EXTRUDED electrode, used with usual polarity of welding current reversed, for the fabrication of stainless steel has been developed by the Lincoln Electric Co., Cleveland. The coating of this electrode contains no carbon, often used as an arc stabilizer, thus eliminating the possibility of the molten weld metal absorbing carbon from the electrode coating dur-

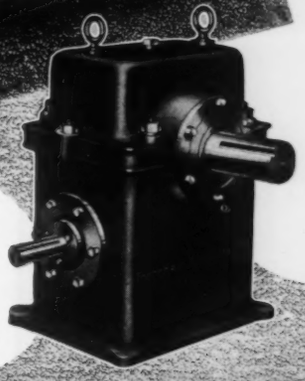
Here's a Book You Ought to Have!



You'll be Interested in

- "Evolution of Worm Gearing"
- "The Customer's Problem"
- "Influence of Design"
- "Influence of Materials"
- "Influence of Proper Selection"
- "Effect of Helix Angle"
- "Effect of Rubbing Velocity"
- "Effect of Bearing and Housing Design"
- "Where You Can Save Money—"

And other subjects



The Most Complete and Understandable Work on Worm Gear Reducers—

NOT a catalog or a highly technical book but a complete engineering treatise on worm gear speed reducers written in simple non-technical language readily comprehensible to the layman.

Complete engineering data, tables, formulæ, layouts, ordering data, lubrication charts and all information necessary to correct selection and highest operating efficiency.

SEND FOR YOUR COPY

Use the Coupon

(MD305)

Foote Bros. Gear and Machine Co.
215 N. Curtis St. Dept. 67
Chicago, Ill.

The IXL HYGRADE Worm Gear Speed Reducer Handbook will be sent without cost to any executive or engineer in U. S. A., Canada or Mexico.

Name .....

Address .....

.....

6-31

Foote Bros. GEAR AND MACHINE CO.
215 N. CURTIS ST. CHICAGO, ILL.

FOOTE BROS. IXL GEAR PRODUCTS

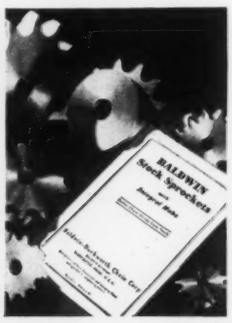
BALDWIN CHAINS AID LARGE SCALE CONSTRUCTION

Industrial locomotive manufacturers select Baldwin Roller Chains for their gasoline locomotives because Baldwin specializes in heavy duty chains. Special alloy steels and correct heat treatments for each chain part have been developed by long experience and the result is *maximum strength for every size and pitch.*

The more exacting the requirements, the greater your need for Baldwin Chains. Consult our special designing service for equipment builders.

STANDARD DRIVES AND SPROCKETS

You can get Baldwin quality in standard drives and sprockets. Consult your nearest distributor. Other Baldwin products are steel replacement chains, precision silent chains, oil well chains, heat resisting chains, etc.



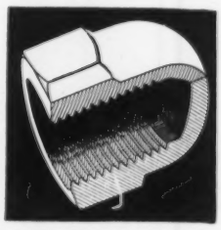
BALDWIN-DUCKWORTH CHAIN CORP.
Baldwin Division, Worcester, Mass.
Duckworth Division, Springfield, Mass.

BALDWIN DUCKWORTH

ing the welding process. As a result of this feature carbon content of weld metal deposited by the improved "Stainweld A" electrode always will be equal to or less than the carbon contact of the stainless steel being welded.

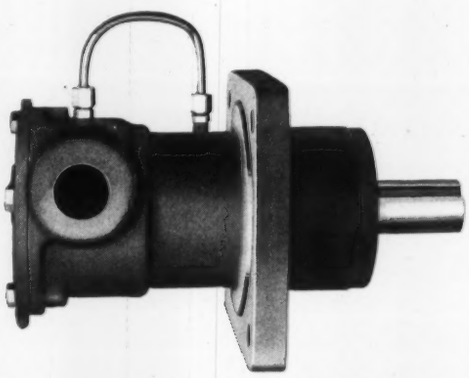
Manufacture One-Piece Acorn Nuts

ONE-PIECE acorn nuts now are being manufactured from solid bars of steel by an improved patented process of blind tapping developed by Acorn Nut Co., Detroit. Extreme accuracy of threads is one of the features claimed for this new process. The solid construction has advantages over two-piece acorn nuts in its greater strength, extra tap depth and durable finish. The nuts, shown in the accompanying illustration, can be furnished in standard sizes, and are used principally to hide unsightly bolt ends where the general over all appearance of equipment must be kept at a high standard.



Pumps Are Reversible in Operation

ROTARY pumps designed for the hydraulic operation of multiple-spindle drilling machines, tapping machines, broaching equipment, and other machine tools are announced by Viking Pump Co., Cedar Falls, Iowa. These pumps, shown in the accompanying illustration, are manufactured in six models, with capacities



Direction of flow may be reversed in new rotary pumps

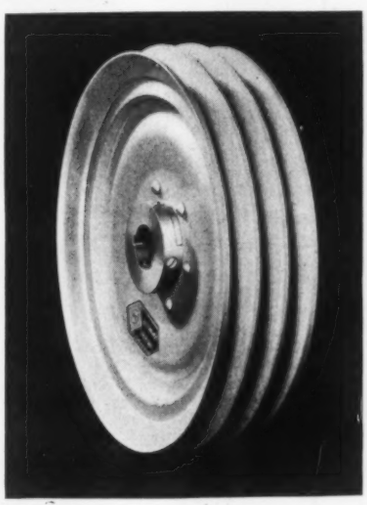
ranging from 5 to 45 gallons per minute at 1200 revolutions per minute. They are suitable for developing pressures up to 500 pounds per square inch. The pump can be furnished separately or in the form of a self-contained motor-driven unit.

In principle, the pumps are constructed with

a rotor and an idler mounted eccentrically with it. As the rotor turns, teeth of the idler mesh with grooves in the rotor, completely filling them. When these grooves come before the inlet port, the idler draws away, creating suction and the opening is filled with liquid. A crescent shaped stop block seals the openings during the period that the idler is furthest away. At the outlet port, the idler and rotor teeth mesh again, forcing the liquid out. The pump is designed with opposite ports, thus eliminating the necessity of specifying "right-hand" or "left-hand." They are reversible in operation and the direction of flow depends upon the direction in which the power drive shaft revolves.

Sheaves Are Balanced Accurately

SHEAVES die pressed from extremely tough steel with the sections welded together both at the web and at the rim to eliminate vibration and noise and to give an accurate balance for true running have been announced by Allis-Chalmers Mfg. Co., Milwaukee. These "Texsteel" sheaves, shown in the accompanying illustration, are light in weight and are manufactured in a large range of diameters, permitting ratios as high as 6:1. They are painted with aluminum paint as protection and to give them a pleasing appearance.



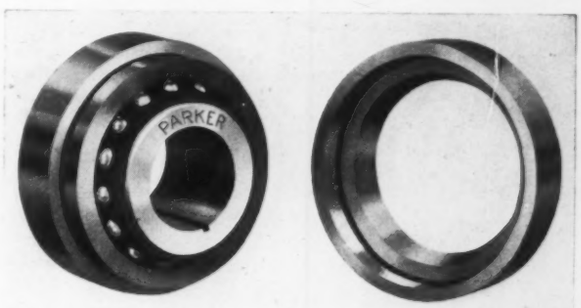
Accurate balance for true running is secured in these sheaves which are die pressed from steel with the sections welded together

New Compensator Regulates Voltage

REGULATED voltage may be supplied to photoelectric cell equipment and similar devices by the use of a new voltage compensator introduced by Sola Corp., Chicago. This compensator has a core divided into two portions. When line voltage drops below predetermined limits, one portion functions as a standard "step-up" automobile transformer and this action builds up to normal voltage. When line voltages rise, the increase in saturation of one arm of the device forces a great portion of flux through a higher reluctance path, thereby an auxiliary coil of opposite polarity counteracts the excess voltage, thus delivering a corrected and steady flow of current.

Eliminates Oil Crushing in Bearing

CRUSHING of the oil is eliminated in the redesign of the Parker ball bearings for high speed requirements developed by Majestic Tool & Mfg. Co., Detroit. This factor formerly has been the principal cause of overheating while operating at high speed. The angular construction of the raceways gives a four-point contact on the balls and forms an oil pocket, eliminating the constant crushing of oil, which in turn eliminates excessive heat.



Special design of bearings eliminates crushing of oil and consequent overheating

In the bearings, shown in the accompanying illustration, the contact point of the ball on one side of the race is farther from the axis of rotation than on the other side. This additional feature causes the ball to rotate with a slightly spiral movement, bringing the entire surface of the ball in contact with the raceways. Thus the wearing of tracks or flat spots on the balls is reduced greatly. There is no end play in the bearing whatsoever. Bearing speed ranges from 10,000 to 60,000 revolutions per minute.

Combine Motor with Gear Unit

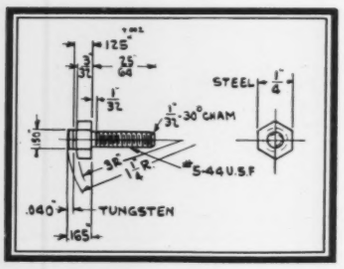
A STANDARD footless stator and rotor, and heat treated alloy steel helical gears, ball bearing mounted and arranged in a compact manner so that the entire assembly is scarcely larger than the motor itself comprises the working parts of the "Rite-Lo-Speed" motor developed by J. D. Christian, engineers, San Francisco. The gear end of the assembly presents a unique design which is not in any way a planetary system, there being only two gears and pinions. It is so arranged that an overhung pull can be

RARE METALS AND ALLOYS

FANSTEEL

best source of supply for

Contact Points



Design . . . to Finished Product

SO important are contact points in the performance of electrical products that Fansteel delegates responsibility to nobody. Every process from original engineering to the final inspector's last test is carried out *in one plant*, under one scientific control. There can be no "buck passing."

Contact metals are refined from ores and basic salts—rods are sliced into discs with *end grain* wearing surface (this process originated by Fansteel)—screws, rivets or other fixtures are made on Fansteel's own machines—and the laboratory keeps a constant check over every step in every process.

All this is done to build an *assurance of dependability* into your contact points. Fansteel will design and make contacts especially for your product—more often your requirements can be met from our large stock of standard types, at substantial savings in time and in cost.

Your inquiry is invited.

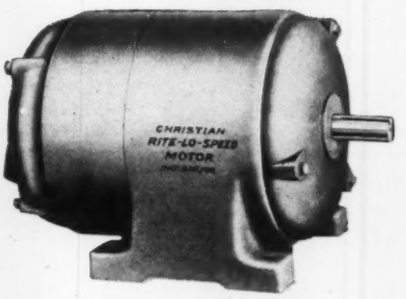
TANTALUM · TUNGSTEN · MOLYBDENUM · CAESIUM · RUBIDIUM

FANSTEEL PRODUCTS COMPANY, Inc.

NORTH CHICAGO, ILLINOIS

taken on the final shaft without the use of an outboard bearing.

The motors, one of which is shown in the accompanying illustration, are made in sizes from 1 to 30 horsepower, and a junior model is made



Heat treated alloy steel helical gears are used to transmit power in this motor

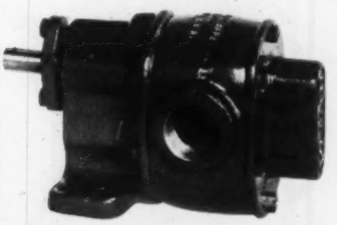
in sizes from ¼ to 1 horsepower. Four styles are being offered as follows: Series A, motor and housing with a single power take-off; series B, single motor with a gear housing at each end having two power take-offs at the same speed; G, the same as B with the exception that the power take-offs are at different speeds; D, a single motor unit with gear housing at one end, with power take-off at reduced speed, and with a high speed motor shaft extended through the rear end bell.

Announce Cut Cords in Six Colors

CUT cords in four standard colors besides the usual black and brown have been made available by Belden Mfg. Co., Chicago, for use with the soft rubber plugs manufactured by the company. Blue, green, red, and gray are the new colors which can be supplied.

Geared Pumps Have Greater Capacity

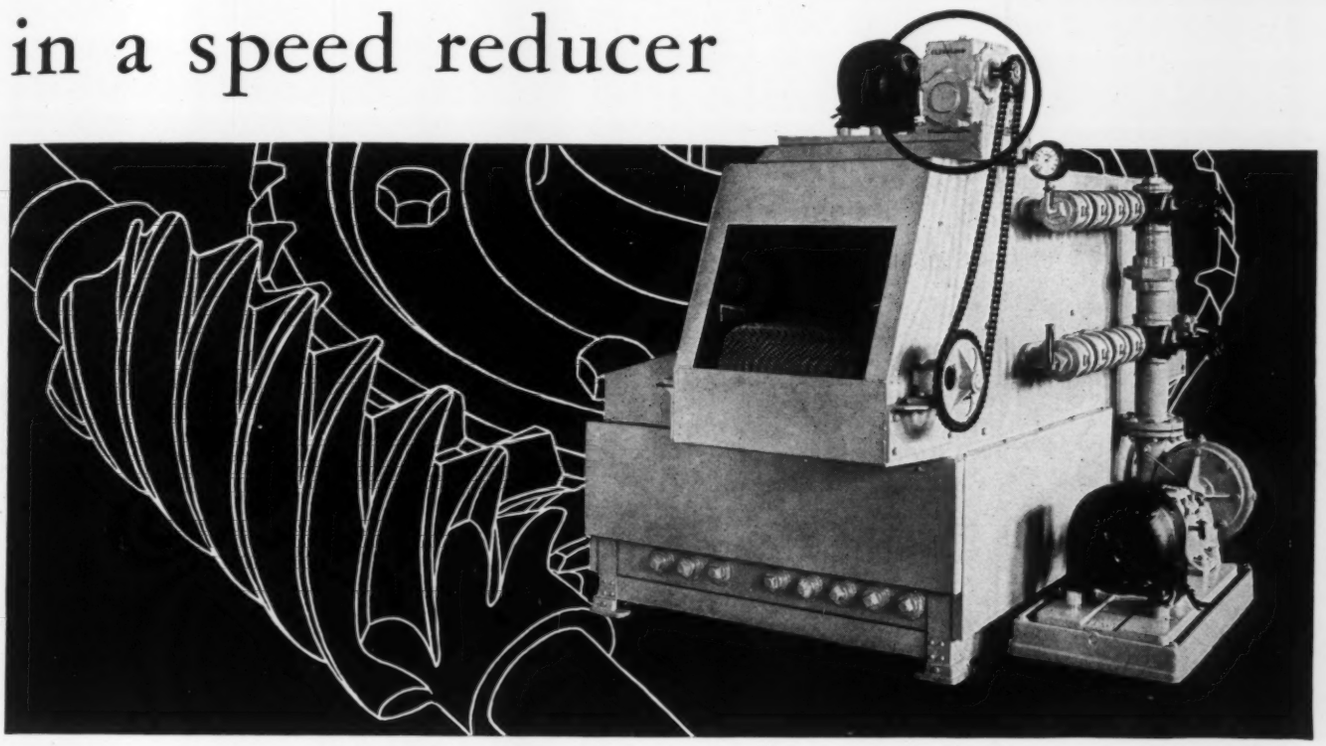
LARGER capacity than that available in previous geared pumps of the company is provided in the new No. 4 pump now being manufac-



Geared pump has 15 gallons per minute capacity at 500 revolutions per minute

tured by Brown & Sharpe Mfg. Co., Providence, R. I. This pump, shown in the accompanying illustration, has a capacity of 15 gallons per minute at 500 revolutions per minute with a

Dependability must be the first consideration in a speed reducer



Cleveland OOD Unit driving a metal parts washer. Ratio 200:1; torque 1000 inch pounds

DESIGNING a worm gear speed reducer of some sort is comparatively easy. Building one that is thoroughly dependable takes exceptional experience and care. "Cleveland" has that experience through 18 years of exclusive worm gear building and insists on extremely high standards in manufacture.

On all production for standard jobs Cleveland begins with the most accurate patterns—three-sided chill castings—equipment that costs real money.

Every ounce of metal entering into the gear is virgin—Lake copper and Straits tin. "Cleveland" does not even use its own borings in the melt, because every time that metal is heated, its characteristics change—"Cleveland" takes no chances.

Steel for worm shafts costs more than ordinary steel—because it is tougher. It requires longer machining time. "Cleveland" gives this steel a double heat treatment and pays extra for normalizing the forgings before they go into the shop.

Cleveland builds its own thread grinders—and its own hobs—more expensive but they turn out a superior product.

And finally, "Cleveland" offers an unequalled engineering service, specializing exclusively in one field, worm gearing and worm gear speed reducers.

The machine builder who specifies "Cleveland" makes his speed reducers an additional, unusually strong sales argument for his equipment. For detailed information on Cleveland Units, write for Bulletins 108 and 110.

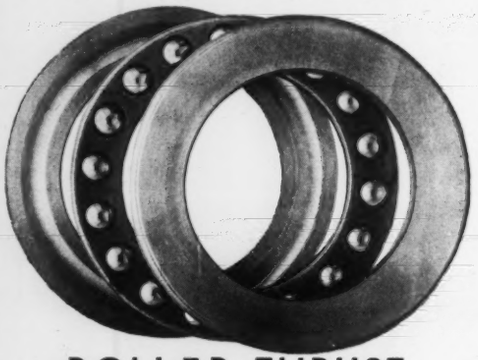
CLEVELAND
WORM & GEAR COMPANY
3275 EAST 80TH STREET . . . . . CLEVELAND, OHIO
CLEVELAND WORM GEARING . . . THE ULTIMATE DRIVE

Cleveland Worm & Gear Company, 3275 East 80th St., Cleveland, Ohio
Please send Bulletins 108 and 110 on Cleveland Worm Gear Speed Reducers.

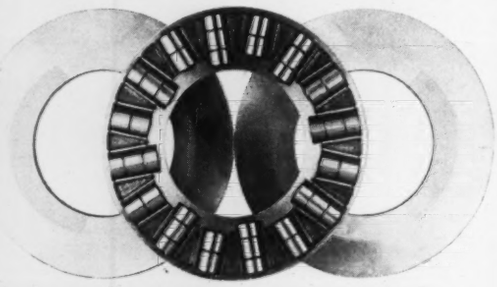
Name_____ Company Name_____

Address_____

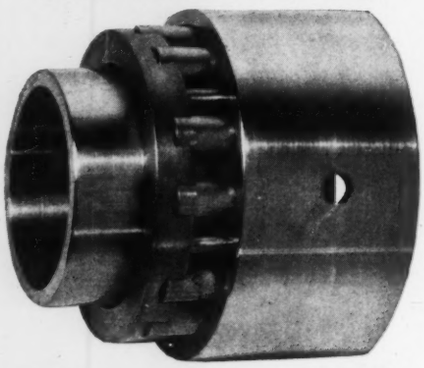
BANTAM
BALL THRUST



ROLLER THRUST



JOURNAL ROLLER



BALL AND ROLLER
RADIAL
BEARINGS
From
1/2 to 48"
One Or A Million
32nd Year
Standard or
Special Sizes

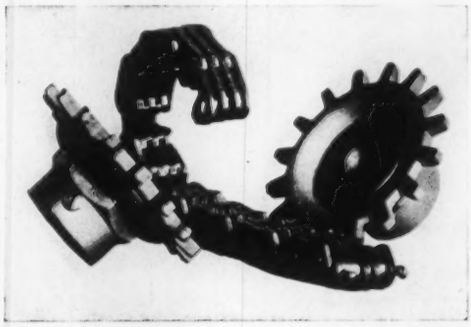
BANTAM
BALL BEAR-
ING CO.
South Bend, Ind.

corresponding increase in discha e of gallons per minute for each 100 R. P. M. up , a maximum of 30 G. P. M. at 1000 R. M.

The No. 4 pump is of the same design and construction as other pumps of the same make and includes all the features possessed by types No. 1, 2 and 3. It is adapted particularly for a coolant pump for machine tools as its volume permits a capacious supply of liquid. For larger machinery it makes an efficient lubrication pump. Where a complete power unit is required, the pump may be furnished electrically driven.

Couplings Provide Shaft Flexibility

SHAFT flexibility in the transmission of power in small horsepower installations is provided by the new Midget coupling designed by Morse



Two sprockets wrapped by a chain makes up efficient flexible coupling

Chain Co., Ithaca, N. Y. This part is a miniature counterpart of the Morse chain-and-sprocket coupling used on installations up to 5000 horsepower. The design, which has been subjected to extensive tests, is unusually simple, consisting of two sprockets wrapped by a chain. It is of all steel construction. The couplings, shown in the accompanying illustration, are manufactured for shaft sizes up to 1 inch diameter.

Lubricator Has No Moving Parts

MOVING parts which might wear or get out of order are eliminated in the design of an adjustable wick oil-feed unit developed by Daun-Walter Co., Milwaukee. Losses from faulty and untimely lubrication thus are prevented, and provision made for positive continuous control over the quantity of oil fed to each bearing. The device, shown in the photograph, consists of two essential elements, the D-W constant level oil control, shown in the front, and the adjustable wick multiple unit. This wick box is of cast aluminum with a removable cover, and is made with 4, 8 and 12 outlet units providing lubrication for a like number of bear-

$17,500.00 REWARD

For Designers *and* Engineers

To the forty-one persons who submit the best papers in the Second Lincoln Arc Welding Prize Competition $17,500.00 will be awarded as follows:

FOR FIRST PRIZE PAPER	$7,500.00
FOR SECOND PRIZE PAPER	3,500.00
FOR THIRD PRIZE PAPER	1,500.00
FOR FOURTH PRIZE PAPER	750.00
FOR FIFTH PRIZE PAPER	500.00
FOR SIXTH PRIZE PAPER	250.00
FOR SEVENTH TO FORTY-FIRST PRIZE PAPERS	100.00 each

The subject matter of the papers must come under one of the following headings:

[a] A description of a useful machine, structure, or building, previously made in some other way, that has been redesigned in whole or in part, so that arc welding is applied to its manufacture.

[b] A description of a machine, structure, or building not previously made that has been designed in whole or in part to the use of arc welding and a description showing how a useful result is obtained which was impractical by means of other methods of manufacture. It is not necessary that the machine as redesigned should have been manufactured at time of writing of the paper.

There are no strings attached to this offer. It is an honest and open competition imposing no obligations upon the contestants.

For full particulars write today to:

THE LINCOLN ELECTRIC COMPANY

P. O. Box 683 • Cleveland, Ohio

Everlock

A LOCK WASHER THAT IS TOTALLY DIFFERENT AND BETTER

U. S. Patent No. 1775705

The Die-Formed Everlock Teeth make the Difference

Note uniform length and depth of impressions made in nut by the sharp Everlock teeth. This is a cut of unretouched photograph, and you can demonstrate the biting power of Everlocks in your own plant.

The teeth of Everlock Washers are die formed, actually shaped—not merely twisted. Wherever there is need for holding a nut, screw, or bolt rigidly tight, Everlock Washers will do it most effectively.

Write for sample and convince yourself of the tremendous holding power of Everlocks. Despite their high locking efficiency, these patented washers cost less than comparable washers of inferior performance!

Mail the coupon for FREE samples and prices.

Thompson-Bremer & Company,
1640 W. Austin Avenue,
Chicago, Illinois.

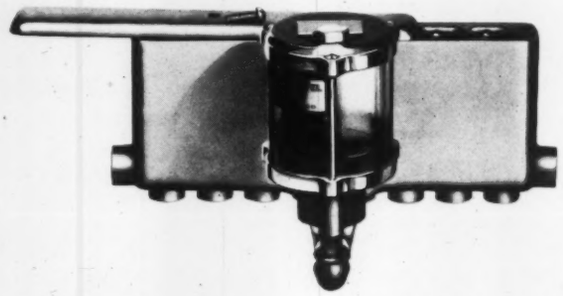
Certainly, we would like to test Everlock Washers. Mail free sample, together with prices, today.

Name.....

Address.....

ings. The amount of oil delivered is regulated from a reserve supply of from ½ pint to two gallons, and may be as low as four drops per hour.

An exclusive feature is the provision made for



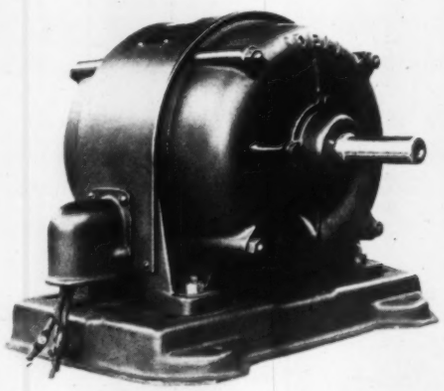
Constant level oil control used with wick feed unit for group bearing lubrication

adjusting the height of turn-down of each wick loop thus controlling the quantity of oil fed by the wick. Capillary attraction draws the oil up over the loop.

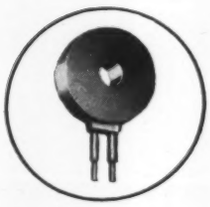
The oil control, which may be obtained separately, automatically regulates and maintains the level of lubricant in the chamber. It also gives a reserve in excess of ordinary requirements.

Fans Protect Motor Against Water

PROTECTION against water or other liquids dripping on it or splashed in through the ends is provided in the design of a unit type motor developed by Ideal Electric & Mfg. Co., Mansfield, O. As water is thrown into the motor, shown in the accompanying illustration, it is discharged immediately through the vent at the bottom of the center enclosing jacket. Air cir-



Internal fans protect motor against water or other liquids



Cast-in unit

Immersion unit

Formed-sheath unit

Cartridge unit

G-E "SPOTS OF HEAT"

now adopted by Champion Shoe Machinery Co.

CHAMPION Shoe machines now have the added asset of G-E Spots of Heat —one 100-watt cartridge unit being used to heat the shuttle case and one 200-watt cartridge unit to heat the wax pot.

These famous Spots of Heat (four different types pictured above), originated and perfected by General Electric, can be built into the machine in the exact zones where they are needed. No piping or accessories need complicate the design. As an integral part of the machine, they supply ideal heat quietly, safely, and without odor — heat that can be controlled sensitively by the turn of a dial. The machine can quickly be moved anywhere within the plant because it carries its heat within itself.

In designing any process machinery requiring heat, call in the G-E heating specialist from the nearest General Electric office and ask him to advise and quote you on the correct type and capacity of G-E Spots of Heat. Often, the specialist can suggest very ingenious applications of these handy electric units.

JOIN US IN THE GENERAL ELECTRIC PROGRAM, BROADCAST EVERY SATURDAY EVENING ON A NATION-WIDE N.B.C. NETWORK

570-151

GENERAL ELECTRIC

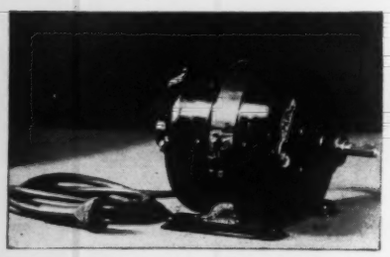
SALES AND ENGINEERING SERVICE IN PRINCIPAL CITIES

culation is from both ends towards the center and out through this vent.

Large shrouded fans located just inside the end brackets at each end of the motor produce the action which discharges the water. These fans catch any water entering through the end of the motor and throw it against the inside surface of the bearing bracket. From here the water runs down the inside of these brackets and out through the vent without coming in contact with the windings. Should water, through unforeseen causes, get beyond the shrouded fans the insulation is so prepared that an occasional wetting will not have any serious effect.

Announce Lightweight Motor

COMBINING light weight with adaptability to any mounting condition, Robbins & Myers Sales Inc., Springfield, O., has brought out a new



Small motors are adaptable to any mounting condition

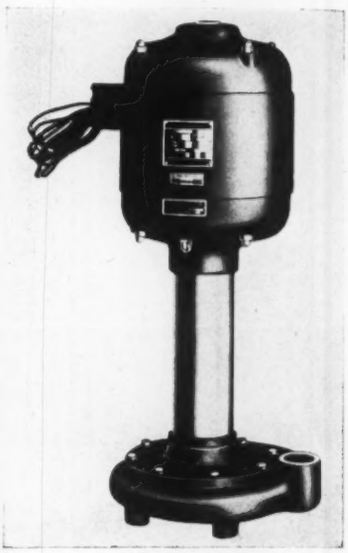
¼-horsepower split phase motor for use on washing machines and similar appliances. This new motor, shown in the accompanying illustration, weighs only 19 pounds, and has a speed of 1750 revolutions per minute. Improved design provides for perfect lubrication regardless of whether the motor is mounted on the floor, side wall, or in an inverted position.

The starting switch is of the centrifugal type with wiping leads constructed for minimum friction wear. Leads are brought out through a molded block which can be removed to permit reversal of rotation by changing the leads.

Pump Circulates Abrasive Liquids

CIRCULATION of liquids containing abrasives and other foreign matter, and of hot parafine, glue and chemicals is accomplished on the pump brought out by Ruthman Machinery Co., Cincinnati. Among the uses of the pump, shown in the accompanying illustration, are pumping grinder coolant, lapping compound, a combination of oil and emery, and honing compound. The pumping action is performed by one revolving part, the impeller, which is so constructed as to prevent clogging, by dispensing of the abrasive material, chips and grit in the water or compound. To eliminate all possibility of injury to the impeller, an intake strainer is provided.

The pump requires no packing, and does not depend upon close fits of any part that comes into contact with the compounds. Ample room is allowed between the impeller and the housing



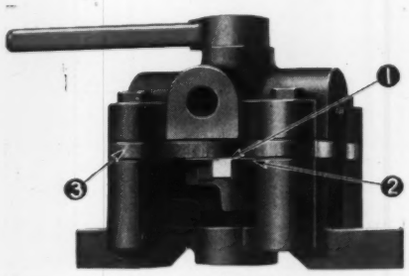
Pumping grinder coolant liquids containing abrasives and similar material is principal use of new pump

to permit foreign matter to pass through freely. The upper end bell, or motor bearing flange, is totally enclosed, thereby preventing dirt, drippings, etc., from entering the motor.

The pump can be furnished for both immersed and outside installations, in several sizes ranging from ¼ to 5 horsepower.

Valve Resists Leakage and Wear

A NEW valve which resists leakage and wear for use with air, steam, water, oil, gasoline, gas, etc., has been announced by Norin Engi-



Bronze to bronze contact eliminates corrosive wearing in new valve

neering Co., Chicago. Even surface pressure is maintained by the resilient disk 2, in the accompanying illustration, which serves to equalize surface pressure on the bronze disk 1 and bronze plate 3, thus assuring tightness. The bronze to bronze contact between plate and disk eliminates corrosive wearing. These three parts, while subject to less than ordinary wear, eventually require replacement. They are interchangeable and can be renewed by removing four small screws, thus effecting complete disassembly.

Have You an application of *this* kind for the flexible shaft? . . .

Aside from its use as a flexible medium for *transmitting power*, the flexible shaft is extensively used also as a means for *transmitting motion* to elements which must be moved back and forth or turned, either by hand or automatically, in cases where the element to be moved is inaccessible, or so located with respect to the controlling element that a straight solid connection from one to the other is not possible.

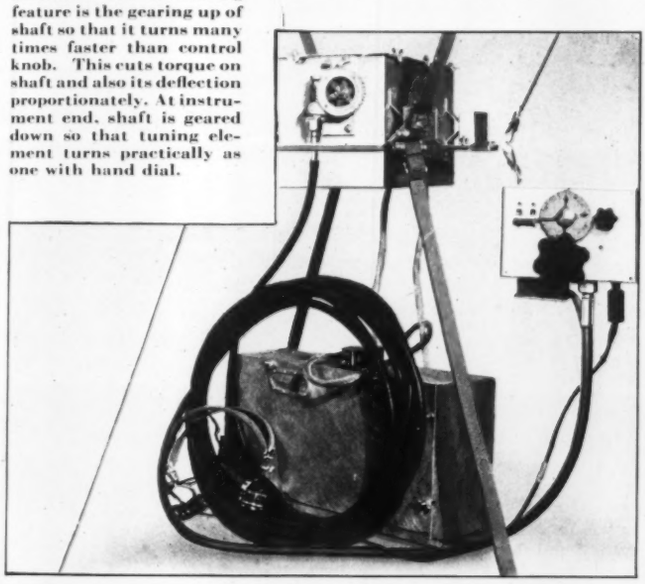
The examples shown make clear the nature of this field of application and are suggestive of the practically unlimited possibilities.

With its wide range of standard shafts, and the flexibility of its manufacturing process which makes readily possible a wide variation in shaft characteristics, the S. S. WHITE Co. can meet the specific requirements of any application of this kind.

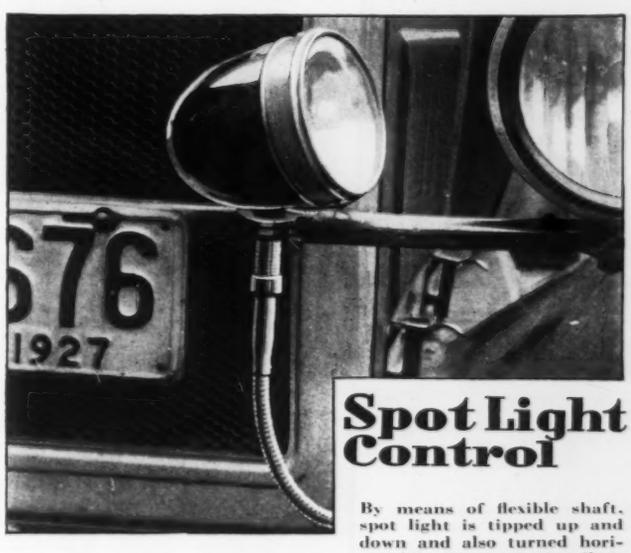
With over 60 years of experience in manufacturing and applying flexible shafts, we are well qualified and equipped to assist in the development of applications and invite your inquiries on specific problems. Address all matters pertaining to flexible shafts to

Airplane Radio Receiver

This application illustrates suitability of flexible shaft for sensitive control, even in long lengths. Fineness of adjustment which tuning calls for, is readily secured. An interesting feature is the gearing up of shaft so that it turns many times faster than control knob. This cuts torque on shaft and also its deflection proportionately. At instrument end, shaft is geared down so that tuning element turns practically as one with hand dial.



The S.S.WHITE Dental Mfg.Co.
INDUSTRIAL DIVISION
154 West 42nd Street,
New York, N. Y.



Spot Light Control

By means of flexible shaft, spot light is tipped up and down and also turned horizontally. Operating handle is conveniently located on dash board. This particular application further demonstrates ability of flexible shaft to withstand constant vibration and rigors of outdoor service.

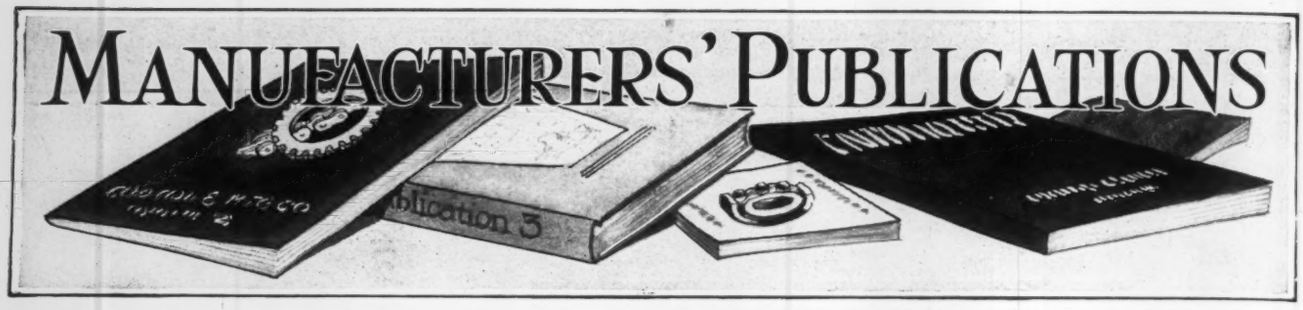
• • • PRODUCTS • • •

S. S. WHITE INDUSTRIAL DIVISION

RESISTORS
FINE CEMENTS
BRONZE CASTINGS
SPECIAL RUBBERS
SILVER SOLDER
GOLD & OTHER PRECIOUS METALS
FLEXIBLE SHAFT MACHINES
DIE SINKERS
ERASING MACHINES
BOILER TUBE CLEANERS
SMALL BURS & DRILLS
GRINDING POINTS
MOLDED RUBBER EARPIECES

Detailed Information on any of these products furnished on request.

MANUFACTURERS' PUBLICATIONS



Publications listed in this section may be obtained by engineers responsible for design from the manufacturers of the products or through MACHINE DESIGN

ALLOYS (STEEL)—Los Angeles Steel Casting Co. Ltd., Los Angeles, has issued a booklet on Nikeladium and other alloys manufactured giving a general description and the results of physical tests on the materials.

ALLOYS (STEEL)—Castings of both carbon and alloy steel intended for use as machine parts are described in an attractive booklet published by Alloy Cast Steel Co., Marion, O. The booklet includes definitions of terms used in such steels, physical properties of the metals, tables giving the characteristics of S. A. E. steels, and other data.

BEARINGS—The Robins-Jones bearing which provides a constant flow of oil around the periphery from an oil reservoir in the base is described in a new booklet No. 81 published by Robins Conveying Belt Co., New York. How the bearing is built, details of operation, and typical applications are given.

BEARINGS—Timken Roller Bearing Co., Canton, O., has prepared a revised edition of its *Engineering Journal* for distribution to executives and engineers in charge of design. The 138-page booklet, in binders, presents in complete form load calculations, bearing ratings and dimensions, cone and cup fitting practice, assembly methods, shaft and housing design, speed-capacity curves, dimension sheets, typical mountings, etc.

BEARINGS—SKF Industries Inc., New York, has brought out booklets No. 205, giving complete and revised engineering data sheets on its line of bearings; No. 204, describing the products of the company; No. 212, presenting a detailed description and engineering data for its pillow blocks and shaft hangers; and No. 203, giving in detail a description of preloaded ball bearings together with methods of analysis.

COUPLINGS—The new small flexible couplings manufactured by Morse Chain Co., Ithaca, N. Y., are described in bulletin No. 40 just issued by the company. The bulletin includes standard sizes, advantages and dimensions.

DRIVES—D. O. James Mfg. Co., Chicago, has published catalog No. 136, covering a complete line of continuous herringbone reducers and gears, and giving dimensions and horsepower ratings according to speed and ratios. Typical examples of installations also are presented.

DRIVES—Steel roller chain which will run over the same sprockets as malleable chain of the same pitch is described in bulletin No. 40 of the Baldwin-Duckworth Chain Corp., Worcester, Mass. The bulletin gives applications, dimensions, and other engineering data.

DRIVES—Chas. A. Schieren Co., New York, has published a booklet entitled "The Effect of Belt Tensions on the Cost of Belting," which presents a nontechnical summary of all factors entering into belt costs, factors to be considered in the selection and specification of belting.

DRIVES—L. H. Gilmer Co., Philadelphia, has issued a new catalog on its line of V-belts. The catalog comprises two sections, the first devoted to theoretical and practical illustrations of the belts and their operation, and the second an engineering section introducing new, simple and original formulas for all V-belt calculations, and including tables and charts.

FASTENINGS—The holding power of hardened self-tapping screws, results of tests on these parts, and suggestions as to applications is detailed in a new booklet prepared by Parker-Kalon Corp., New York.

FASTENINGS—Everlock lock washers which hold the nut in place by means of die formed teeth are described in a pamphlet by Thompson-Bremer & Co., Chicago. The pamphlet also gives an outline of how the washers work, advantages to be obtained by their use, and a list of sizes.

LUBRICATING EQUIPMENT—Ideal Lubricator Co., Philadelphia, has issued an illustrated booklet describing its system of controlled lubrication, giving typical installations of the equipment.

LUBRICATING EQUIPMENT—Gits Bros. Mfg. Co., Chicago, has prepared a booklet on its line of automatic multiple oilers which are hand, air, electrically or mechanically operated. Uses, dimensions, capacities, and a description of the equipment are given.

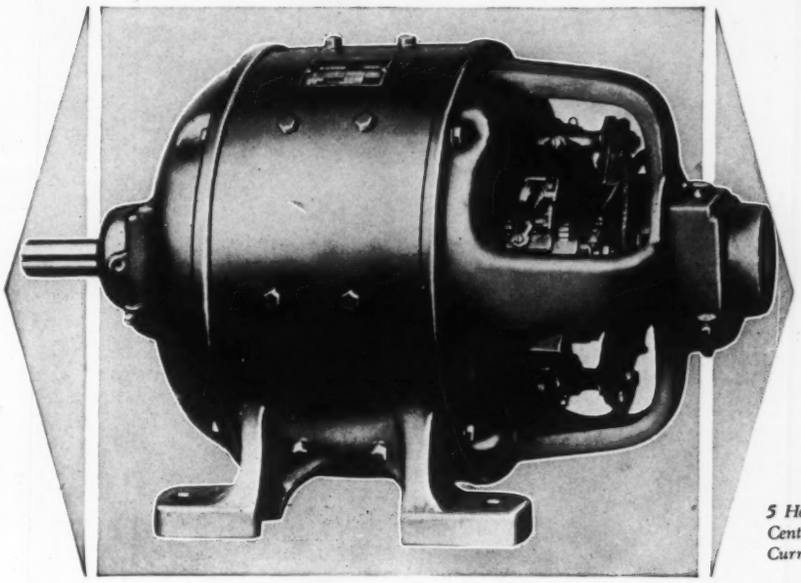
MOTORS—Louis Allis Co., Milwaukee, has issued bulletin 500A which explains the principle, connections, and applications of the company's multispeed motors, and bulletin 508A which gives the principle and advantages of explosion proof, fan cooled motors.

MOTORS—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has published Leaflet 20385-A, "Type CS Squirrel Cage Induction Motors," which describes the new W-frame motor. The new motor has interchangeable mechanical and electrical parts.

MOTORS—Seven distinct types of squirrel cage motors compared as to their starting torques and starting currents are described in a new bulletin No. 165 issued by Wagner Electric Corp., St. Louis. Construction details are illustrated, and speed-torque curves and tables make a thorough comparison of the various types.

PUMPS—A new circular, published by Brown & Sharpe Mfg. Co. lists the complete line of pumps which this company manufactures, including pumps of gear, vane and centrifugal types.

THEY KEEP A-RUNNING



5 Horse Power Century Direct-Current Motor

CENTURY
Adjustable Speed
DIRECT-CURRENT MOTORS

Century Direct-Current Adjustable-Speed Motors are designed for constant torque, constant horse power or variable torque to meet the requirements of such installations as fans, blowers, stokers, machine tools, textile machinery and other exacting installations where speed adjustment is necessary to assure comfort and health, or economical operation.

Their service continuity is the result of 37 years spent by the Roth Works in perfecting Direct-Current Motors that "Keep a-Running" in all types of direct-current applications.

Built in standard sizes from 1/4 to 100 horse power.

CENTURY ELECTRIC COMPANY
1806 PINE ST. · · ST. LOUIS, MO.
40 U. S. and Canadian Stock Points and More Than 75 Outside Thereof

SINGLE PHASE, THREE PHASE, AND DIRECT CURRENT MOTORS

Century MOTORS

MOTOR GENERATOR SETS, ROTARY CONVERTORS, FANS AND VENTILATORS

D035

FOR MORE THAN 27 YEARS AT ST. LOUIS